PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

JUNE, 1937

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Contents

TIMEWASTERS

Back to the Land:

A man buys a square farm at $160 per acre. He pays for it with silver dollars, which are 1½ inches in diameter. If it takes just enough dollars to lay around the entire farm, laying them so that the center of the dollars will be on the exact line of the perimeter, how many acres did he buy, and what was the total cost? *Contributed by H. A. Blunk.*

Are You Color Blind?

Five men, whose names are Black, White, Gray, Green and Brown, have the following occupations: Painter, aviator, doctor, clerk and salesman. Determine the men's occupations from the following data: "While the salesman was under the care of Dr. Black, Gray, who is not a clerk, asked Brown to take a confirmation of an order from the aviator who wanted his plane painted the same color as his name. *Contributed by Charles W. Manley.*

There's a little catch in the above, so consider thoroughly before you write us that it can't be done.

To the Coronation? Or Is It New England?

A and B traveled on the same road and at the same rate from Huntingdon to London. At the 50th milestone from London, A overtook a drove of geese which was proceeding at the rate of 3 miles in two hours; and 2 hours later met a wagon, which was moving at the rate of 9 miles in 4 hours. B overtook the same geese at the 45th milestone and met the wagon exactly 40 minutes before he came to the 31st milestone. Where was B when A reached London? *Contributed by John Bevan.*

From Last Month:

Yes, there were three girls on the street corner, one red-head, one blonde and one brunette. That Uphill Problem was easy, or should have been, for the highway designer. If the grade was 5%, and the total rise was 200 feet, the road would be 4,000 feet long. We haven't worked out the cow and locomotive problem yet, but will get at it soon.

No further word has been received on the flag-pole problem, and we haven't had time to mess with it, what with the dandelions in the lawn and other pressing problems of that sort; also it is getting on toward fishing time, which requires some attention after the rush of the spring. Hope we shall see some of our Timewaster contribs at the American Water Works Convention in Buffalo. W. A. H.

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A. PRESCOTT FOLWELL, Editor **W. A. HARDENBERGH, Asso. Editor**

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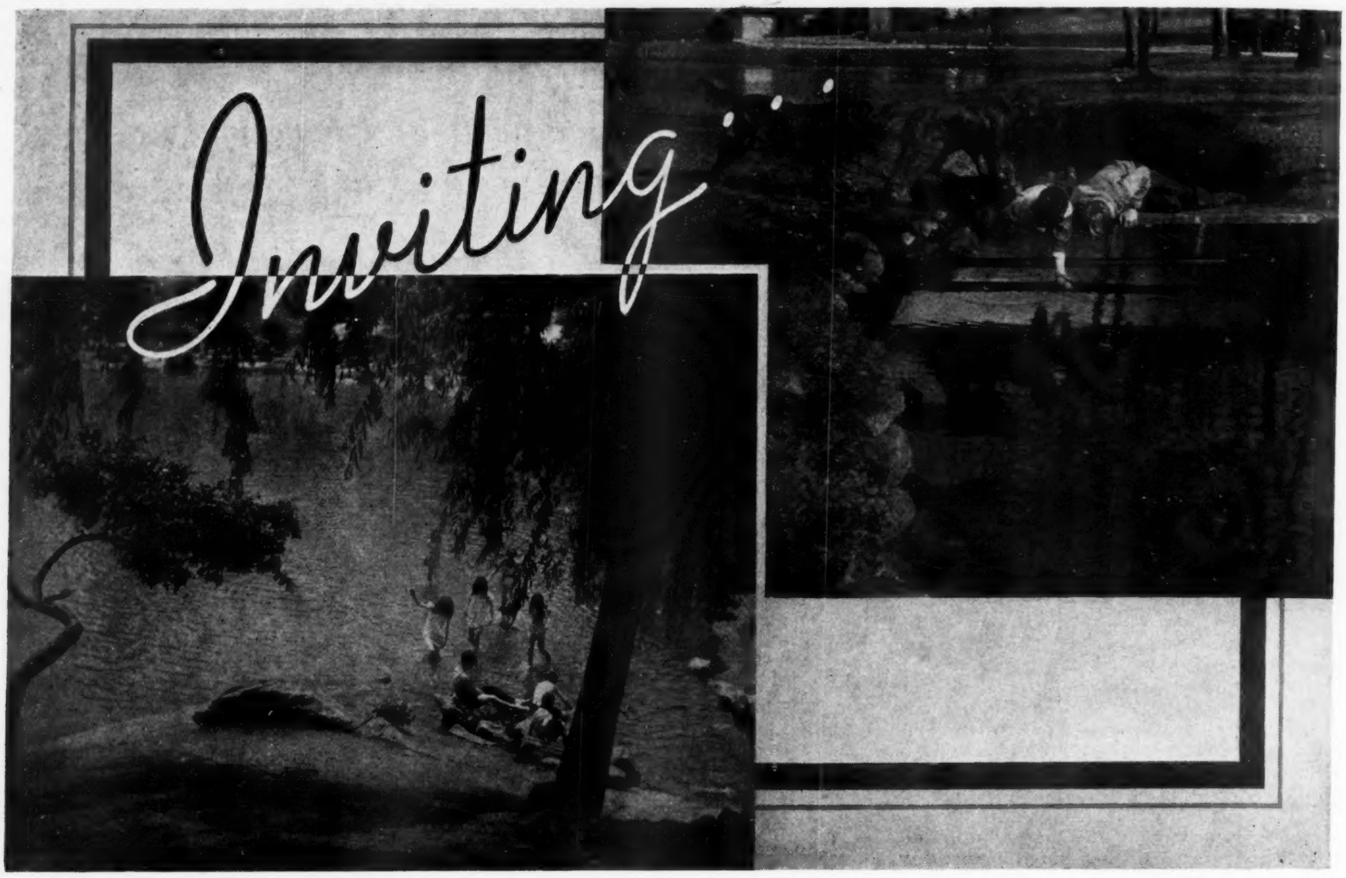
Inviting . . .

PUBLIC WORKS

City, County and State Engineering and Construction

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Buffalo's Water Waste Problem and Its Solution

By LEONARD S. SPIRE

Chief Pitometer Operator, Division of Water, Buffalo, N. Y.

SHAKESPEARE once said, "Much water goeth by the Mill that the Miller knoweth not of . . ." The problem of how to control water in the city's distribution system is one of the most important items in the conduct of the city government. The price of fuel and chemicals and increased cost of extensions which are necessary if water waste is not curtailed is a factor in the operation of the water department which should be seriously considered.

For a great many years the City of Buffalo pumped more water per day for each resident than any other city in the United States. The per capita consumption was enormous and far exceeded any reasonable requirements of domestic and commercial uses. Additional large mains and pumping machinery of unusual capacity had to be installed in order to supply the necessary amount of water. The contributing factors to this large consumption, the low water rates and the sentiment which prevails that, with ample supply available, not even a reasonable limit on the consumption could be tolerated, had resulted in futility of attempts to permanently curtail this waste.

In 1903 there was one pumping station with a daily capacity of 183,000,000 gallons. In 1917 there were two pumping stations with a combined daily capacity of 330,000,000 gallons. During this period the per capita consumption had ranged between 302 and 350 gallons per day.

In 1916 the city government was altered and a commission of five men elected to govern the city. Their platform was an economical and efficient city government, and one of the early efforts was an investigation as to means to reduce city water consumption. As all water used must be pumped from Lake Erie against a head of 140 to 204 feet, a reduction in pumpage would make an immense saving in coal used for fuel. Various methods were considered and in the Spring of 1917 it was decided to employ the Pitometer Co., Engineers, of New York City, to make a water waste survey of a small section of the city, with the idea of covering the whole city later should this sectional survey show satisfactory results. The question of metering was considered, but was rejected on various grounds, some of which were: popular prejudice against metering; length of time to completely meter the city, there being over 70,000 unmetered and active services, while the pitometer method promised early results; extensive changes in plumbing required should meters be installed in many of the poorer types of dwellings; and heavy initial investment required for meters.

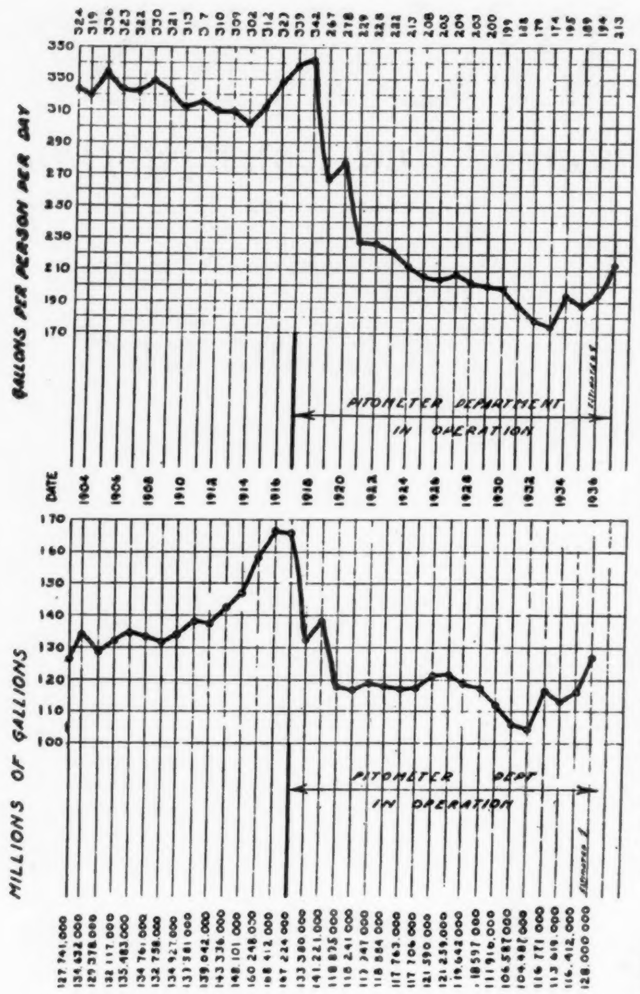
Leonard S. Spire

The results of the preliminary survey of the small section proved to be so satisfactory that the city entered into a contract with the Pitometer Co., to make a complete water waste survey of the entire city, this survey to cover a period of two years.

During the fiscal year 1916-1917, when the Pitometer Co. started their survey, the combined pumpage of water of the two pumping stations was 61,491,000,000 gallons. The average daily consumption was 168,468,000 gallons and the daily per capita consumption 350 gallons. At the conclusion of this two-year survey the yearly pumpage was 48,687,000,000 gallons, the average daily consumption 133,380,000 gallons and the daily per capita consumption 277 gallons. It will be seen from the foregoing figures that a huge reduction in pumpage was caused through a systematic pitometer survey which located and stopped thousands upon thousands of leaks. The actual saving in pumpage from this survey amounted to 12,804,000,000 gallons per year, 35,088,000 gallons per day and 73 gallons per day per person.

On July 1st, 1919, the Pitometer Co. completed their contract and their system was continued under a newly formed permanent Pitometer Department of the Division of Water. The personnel of the newly created department consisted of a chief pitometer operator, two pitometer operators in charge of district and night subdivision measurements, two crews of four men each to operate valves, and from 15 to 20 inspectors who made house to house inspections where pitometer measurements showed unusually high rates.

In 1916 the National Board of Fire Underwriters, in a report of their survey of the Water Department, stated: "The per capita consumption is enormous and far exceeds any reasonable requirements of domestic and commercial uses. Both the total and per capita con-



Above—Per capita consumption, 1904-1937.
Below—Average daily consumption, showing effect of pitometer survey.

sumption have increased in recent years, requiring additional large mains and pumping machinery of unusual capacity. The carrying capacity of the arterial system should be ample, but owing to the enormous consumption is severely taxed and large friction losses occur. . . . This can be overcome only by a campaign of education against unnecessary waste, the beginning of which cannot be made too soon." During the two-year period of the Pitometer Co.'s survey they reported the following number of leaks: 50 unfinished supplies, 1,869 services, 15 abandoned services, 203 hydrants, 32 joint leaks, 12 broken mains, 9,152 faucets, 27,931 toilets and 12 miscellaneous leaks—a total of 39,276 leaks. The services, broken mains and leaky joints accounted for 12,000,000 gallons waste per day. These were repaired and the waste permanently stopped. Repairs to plumbing fixtures are only temporary as they are apt to break out at any time, hence the necessity of continuous house to house inspections. Prior to 1919 there was an excessive waste of water through the anti-freezing type of closet. There were upwards of 10,000 of this type of closet installed in the older sections of the city, the majority of them in bad repair. These have been almost entirely eliminated, which has caused a large saving in the pumpage.

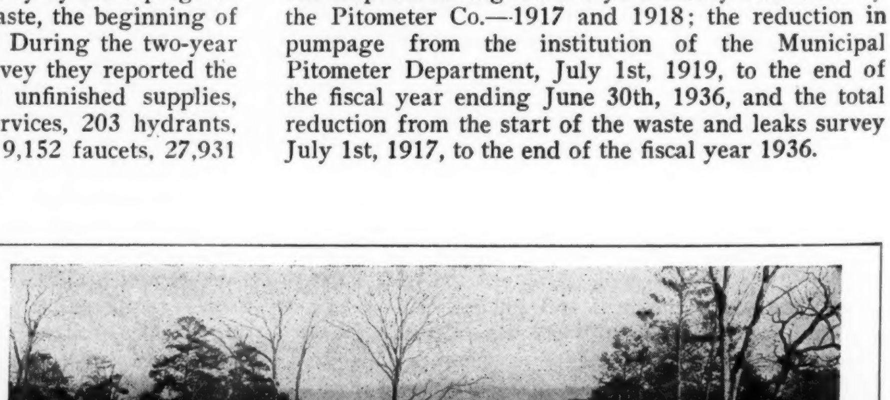
During the year 1926, the National Board of Fire Underwriters made a survey of the city and in their report, under the heading "Consumption," stated: "Statistics are based upon the pumpage as recorded by venturi meters. As there are practically no private sources, the municipal works furnish the entire supply for the city and it is estimated that the industrial uses amount to a daily per capita of 75 gallons. At the time of the National Board survey in 1916 the per capita consumption averaged 350 gallons per day and was increasing. In 1926 it was 210. This control of consumption and curtailment of waste has been accomplished mainly by the maintenance of a Pitometer Department which operates continuously, measuring the consumption by districts and making inspections for leakage in those districts in which unwarranted increases occur." The Municipal Pitometer Department, continuing the system started by the Pitometer Co., succeeded in further reducing the pumpage year by year as illustrated in the following tables:

Fiscal Year	*Total Pumpage*	*Average Daily Pumpage*	*Daily per capita*
1916-1917	61,491,000,000	168,468,000	350
1918-1919	48,687,000,000	133,380,000	277
Reduction	12,804,000,000	35,088,000	73
1918-1919	48,687,000,000	133,380,000	277
1935-1936	42,607,000,000	116,412,000	194
Reduction	6,080,000,000	16,968,000	83
1916-1917	61,491,000,000	168,468,000	350
1935-1936	42,607,000,000	116,412,000	194
Reduction	18,884,000,000	52,056,000	156

The above tables represent the amount of saving in consumption during the two-year survey conducted by the Pitometer Co.—1917 and 1918; the reduction in pumpage from the institution of the Municipal Pitometer Department, July 1st, 1919, to the end of the fiscal year ending June 30th, 1936, and the total reduction from the start of the waste and leaks survey July 1st, 1917, to the end of the fiscal year 1936.

Work on the Birmingham Industrial Water Supply

Constructing one of the reservoirs for the new water supply for Birmingham, Ala. (See Public Works for Dec., 1936.) Caterpillar tractors and Le Tourneau scrapers are shown.



The recent depression had its effect upon the water consumption in many ways. The slump in business and closing down of factories reduced the pumpage, and the revenues from industrial and commercial users of water fell to the lowest mark experienced in years. Perhaps the foremost thought in the minds of all municipal officials was the problem of relieving unemployment and the care of the needy. An emergency existed and had to be met. Budgets covering all departments, excepting welfare departments, were slashed, skeleton crews were maintained in order to "keep the wheels turning" and department heads were cautioned to keep running expenses down to the lowest minimum. The Pitometer Department was one of the departments which was seriously hampered as funds were not available to continue the Pitometer measurements, and with few inspectors available little progress could be made. It is hoped and expected that the budget for the coming fiscal year will contain sufficient funds for the Pitometer Department to resume its normal functions and thus enable it to make inroads on the increasing pumpage. The direct benefit from the work of the Pitometer Department has been a reduction of coal, oil and labor at the pumping stations amounting to approximately $90,000 a year. The indirect benefits, such as postponing the time when larger feeder mains and additional pumping units will be needed, have amounted to several hundred thousand dollars in capital investments.

To illustrate the effect of the depression on the pumpage of water, the pumpages during the fiscal years 1929-1930 to 1935-1936 are given in the table at the bottom of this page.

Coal Savings

Fiscal Year	*Deficiency from 1916-17 in tons of coal used for pumping*	*Cost of Coal Per Ton*	*Savings in Coal*
1917-18	1,764	$4.28	$ 7,549
1918-19	11,286	4.42	49,884
1919-20	8,925	3.95	35,252
1920-21	15,502	7.10	110,064
1921-22	15,567	4.06	63,202
1922-23	15,912	5.75	91,494
1923-24	16,351	3.60	58,863
1924-25	16,400	3.53	57,892
1925-26	16,542	3.43	56,739
1926-27	17,413	3.71	64,602
1927-28	17,325	3.91	68,607
1928-29	17,753	3.35	59,472
1929-30	17,763	3.10	55,065
1930-31	19,237	3.08	59,249
1931-32	20,478	2.99	61,229
1932-33	20,995	2.88	81,460
1933-34	17,532	3.58	62,764
1934-35	18,744	3.94	73,851
1935-36	17,325	3.60	62,370
TOTAL SAVINGS			$1,169,609

The domestic supplies in Buffalo are about 18% metered. This necessitates a continuous and vigilant house to house inspection for leaking plumbing fixtures in approximately 80% of all the domestic services in the city. Each year pitometer inspectors report between 25,000 and 30,000 leaking fixtures and between 1,500 and 2,000 underground service leaks. Careful computation shows that the average amount of water wasted is 1,000 gallons per leak per day, or a total of all leaks reported during the year of between 25,000,000 and 30,000,000 gallons per day.

Top—One of the Department's pitometer recorders. Bottom—Leak in a Buffalo main discovered by the pitometer.

If the property holders would use more care and repair the leaking fixtures as soon as they are discovered, the Division of Water would save thousands of dollars yearly in its coal bill. The property holder who keeps his plumbing fixtures repaired has to help pay for the water wasted by his neighbor who is careless and neglects to have the leaking fixtures repaired.

Effect of Depression on Pumpage

	1929-1930	*1930-1931*	*1931-1932*	*1932-1933*	*1933-1934*	*1934-1935*	*1935-1936*
Total	43,287,910,000	40,859,400,000	39,040,760,000	38,162,370,000	42,621,460,000	41,471,200,000	42,607,000,000
A. D. C.	118,597,000	111,916,000	108,319,000	104,554,000	116,771,000	113,619,000	116,412,000
Per Cap.	199.3	188	180.5	174.2	196.6	189.3	194

The Relation Between Safe Highway Lighting and Night Accidents

The important and interesting facts in this article are from a talk by Dudley M. Diggs of the General Electric Illuminating Co. before the meeting of the Association of Highway Officials of the North Atlantic States.

ACCIDENT records show that during the normal hours of daylight (6 A. M. to 6 P. M.) in 1935 there were 14,620 fatalities. Fatalities occurring during the normal hours of darkness (6 P. M. to 6 A. M.) totaled 21,480. Preliminary figures from the National Safety Council for 1936 show an increase in fatal night accidents.

These figures show that more than one-half of all fatal accidents occur after sunset. Yet, only one-fifth of the total traffic flows at night; night driving is at least four times more dangerous than day driving, and on many highways it is from six to ten times more dangerous. There were 33,000 more accidents during the daylight hours of 1935, and yet there were 7,000 fewer deaths; if you are in an accident at night, you are 92 per cent more likely to be killed than if you are in a day accident. Night accidents are generally far more serious and fatal.

From 1930 to 1935, city deaths declined 10 per cent, whereas deaths on the "open road" increased 28 per cent. Figures for 1936 are in line with these trends.

What Causes These Night Accidents?

The Travelers Insurance Company of Hartford, Connecticut, recently collected the official reports of *all* accidents in the United States and analyzed them. Let us examine the report to find the main cause of the worse accidents.

Was it the weather? No. Of every 100 auto crash funerals, only 2 resulted from accidents that occurred while it was snowing, only 3 from accidents that occurred in fog, and only 10 from accidents that occurred while it was raining. The official reports do not say that these accidents were due to snow, fog, or rain; they simply state that the accidents occurred when it was snowing and raining, or while it was foggy. In other words, 85 out of 100 accidents took place in perfectly clear weather.

Then, were slippery roads to blame? No. Out of every 100 auto crash deaths only 2 were from accidents that occurred on snowy roads. Only 5 on ice, and only 16 on wet pavements. Again, the reports do not say that these accidents were due to the road conditions. In other words, 77 out of 100 deaths took place on dry roads.

What of drunken driving? Only 7 out of every 100 drivers of death cars were reported to have been under the influence of alcohol. Drinking and driving do not mix, but liquor is not the main cause of our worse accidents. Only 9 out of 100 pedestrians killed were under the influence of liquor.

Were mechanical defects to blame? No. Only 2 out of every hundred cars involved in fatal accidents were reported to have had defective brakes. Only 1 out of every 100 was being operated without chains when chains were needed. Only 1 out of 200 had defective steering mechanism. Ninety-two per cent of all cars involved in fatal accidents were reported apparently in good condition.

Decreased and Inadequate Visibility

Almost any warning sign is infinitely superior to the scant warning of danger ahead provided by our headlights. The motorist relying on them has but a short 1 to 5 second warning of danger.

Present average automobile headlights enable the average driver to see the average "dark" object about 150 feet ahead. A car going 50 miles an hour goes 73 feet each second. When a "dark" object suddenly looms up 150 feet ahead, it means that there are but two seconds in which to see, comprehend the danger, decide, take the foot off the accelerator and slam it on the brake, to judge the size and direction of the object, to blow the horn, and to turn the steering wheel—all at once.

The warning is much too short. A car traveling 50 miles an hour travels from 186 to 243 feet after the warning is transmitted to the brain by the eyes, and before the car can be brought to a standstill—depending on the condition of the brakes, the road, and the driver.

Is There a Way to Decrease Night Accidents?

Let us study the close relationship between light and accidents on the Mount Vernon highway leading into Washington. When the lights were turned off along this parkway a few years ago, night accidents jumped two and a half times. When all lights were in service, nine night accidents occurred over a six-month period. When all lights were turned out, and with the same number of vehicle miles traveled, 22 night accidents were recorded over a similar six-month period the following year.

In New Jersey we find two comparable highways in Route 25, which is lighted by permanent lamps, and Route 26, along which motorists must depend upon their headlights. Route 25 is safer by night than it is by day. Route 26 is about three times more dangerous to travel by night than by day. The rate per million vehicle miles during daylight on Route 25 is 3.10; the night rate is 2.61. On unlighted Route 26, the daytime rate is 2.42; the night rate is 7.70.

An eight-hour survey of accidents on the Troy-Schenectady highway in New York State, four years before and four years after lighting, shows a night accident decrease of 36.4 per cent during the 4 years of lighting, while daytime accidents increased 9.7 per cent during this period.

To install a modern safety lighting system along a highway costs but 5 to 7 per cent of the cost of the highway. To operate it costs but one-third of the money it would save in property damage alone, according to data given by Mr. Diggs.

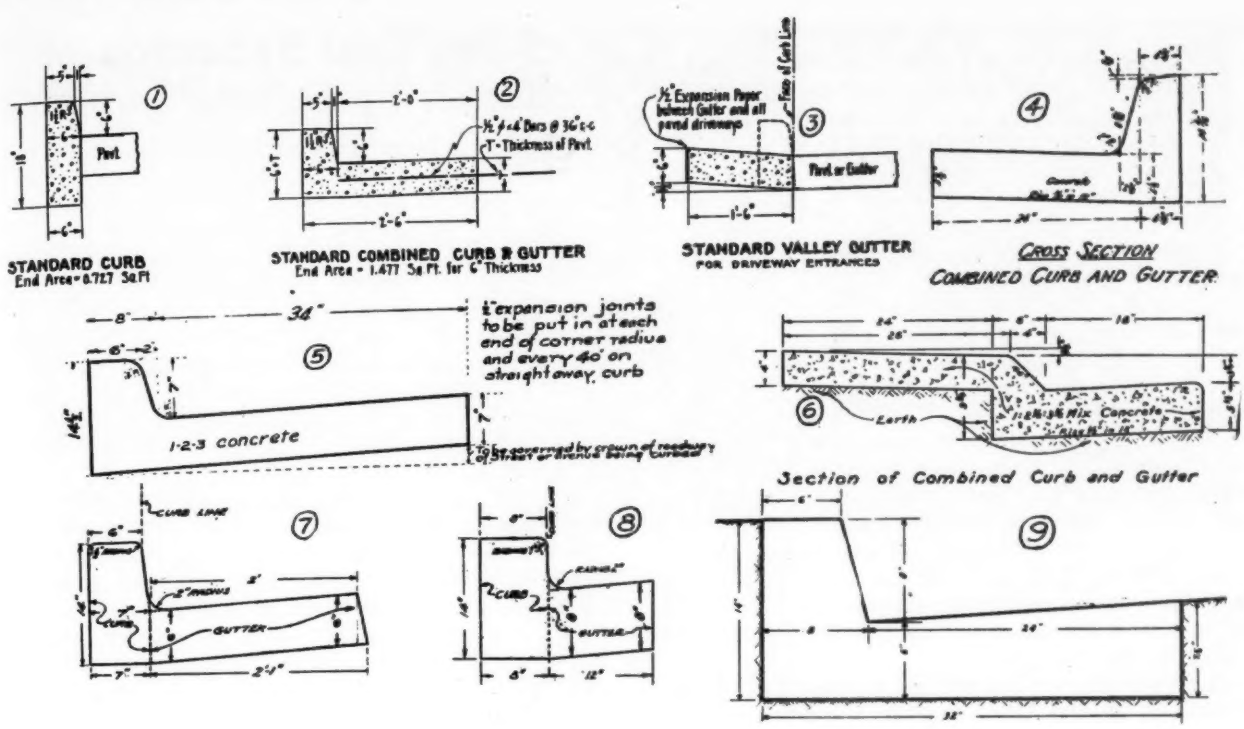


Fig 1. These curbs and gutters are described in the accompanying text.

Curb and Gutter Designs in American Cities

The Editor of PUBLIC WORKS recently asked a number of representative city engineers to send him prints of their standard curb and gutter designs. Some interesting prints have been received, a few of which are illustrated and described in this article. At the same time, designs for manholes and storm water inlets were asked for. Illustrations and descriptions of these will appear in an early issue; and also more of the curbs and gutters will be shown as space permits.

MODERN traffic conditions have brought about certain changes in curb and gutter design. In order to reduce wear on the sidewalls of tires, many cities now build their curbs with a sloping face; gutters and curbs are designed also for parking automobiles, this being their principal utility most of the time. In parking also, the sloping face is desirable as it minimizes the tendency to pinch tires between the curb and the rim if the driver does not stop his car quickly enough. Curbs are also lower than formerly; many of them are reinforced, which subject will be treated in a later article.

In Fig. 1, items 1, 2 and 3 were sent us by S. H. Smith, city engineer of South Haven, Mich. The standard curb, as shown, has a slope of 1 inch, and is 6 inches high and 18 inches deep. The combined curb and gutter is pavement thickness plus 6 inches, and extends 2 feet beyond the curb, being tied to the pavement with ½-inch round bars, 4 ft. long, spaced 36 inches apart. The standard valley gutter is shown in 3, Fig. 1. Item 4 of Fig. 1 was sent us by Albion K. Vickery, city engineer of Denver, Colo., as was item 6, just beneath it. The combined curb and gutter (4), is more than 8 inches high and has a slope of 2⅜ ins. Item 6, Mr. Vickery says, is a new design for one of their proposed improvements districts, consisting of a narrow walk adjoining a sloping 4-inch curb with an 18-inch gutter. Item 5, Fig. 1, was sent us by F. E. Young, city engineer of Cedar Rapids, Iowa, and the illustration shows all essential information.

Items 7 and 8 of Fig. 1 are from Oakland, Calif. C. A. Reed, street improvement engineer, in an accompanying letter says: "The 6-inch curb and 2-ft. gutter are used on our residence streets, with a penetration macadam pavement, and the 8-inch curb and the 1-ft. gutter are used on our main arteries which may be paved with an asphaltic concrete surface course on either a portland cement base or an asphaltic concrete base. Or the 8-inch curb is cast integrally with the pavement, if of concrete."

Archer B. Stuart, city engineer of Healdsburg, Calif., sent us item 9 of Fig. 1, and states in connection with it: "We carry this same batter around corners with a radius of from 12 to 20 ft. or longer. At present we are constructing 30,100 lineal ft. of this curb and gutter with WPA labor at a cost to property owners of 20 cents per front foot. We use a floated and brushed finish with street names and block numbers stenciled eight times at intersections and often in the middle of long blocks. The mix is five sacks (of cement) per yard of clean natural gravel and sand aggregate, which gives a 3000-pound concrete.

J. H. Rough, village engineer of Hibbing, Minn., sent us the designs marked 10 and 11 of Fig. 2. The

former is a combined curb and gutter, 6 inches high with a 2-inch slope, with a 4-inch tile underdrain and a bed of gravel placed under the curb and gutter. The latter shows the detail of a straight curb. Both are made of 1:2:3 concrete. Illustration 12 of Fig. 2 shows the standard curb and gutter section of Topeka, Kans., W. E. Baldry, city engineer; also the straight curb, and the gutter section.

In Fig. 2, 13 and 14 were sent us by S. E. Minor & Co., civil engineers of Greenwich, Conn. The former shows a gutter of telford, or large stones. The minimum depth of gutter stones is 10 inches; the width of gutter is 3 ft. 3 ins. The flow depth is 6 inches. The joints between the stones are filled with gravel and hot asphalt, flush with the surface. The lower illustration, 14, shows a telford gutter with sand filler. This is laid on a 3-inch sand bed, the stones should be 8 inches deep, and the flow depth of the gutter is 6 ins., with a total width of 40 ins. The straight concrete curb used by this firm has a top width of 7 ins., and bottom width of 9 ins., a depth of 20 ins., and the batter on the front face. This curb is constructed with an 8-inch face showing to permit for future surfacing of the street to give a final height of 6 ins.

C. A. Mason, city engineer of Hammond, Ind., furnished 15, 16 and 17 of Fig. 2. The top illustration shows the standard combined curb and gutter and the curb, with the method of setting. An unusual form of curb and gutter for street crossings is shown in 16 and 17, along with dimensions and other data.

Standard curb of Mobile, Ala., as sent us by Harry L. Fisher, city engineer, is straight, but with a rounded top corner; it is 1:2:3 mix, 18 ins. high and 5 ins. thick. Expansion joints are formed every 6 ft. by inserting a slotted ⅛-inch metal plate spreader and leaving this in place until the concrete has set. A No. 10 wire is inserted in the concrete through the slots near the top and bottom of the curb, which holds the curb in perfect alignment after forms are removed. Mobile, because of its very flat grades, has abandoned the integral curb and gutter.

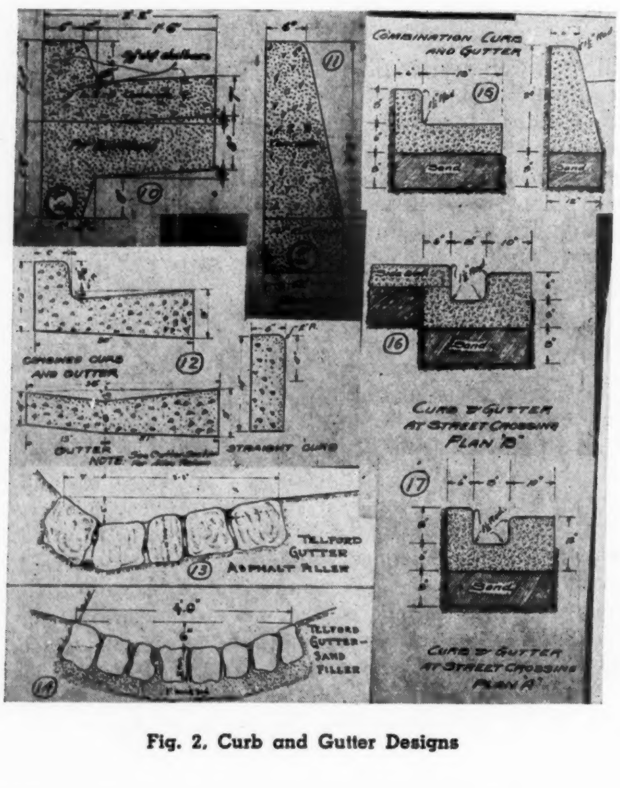


Fig. 2. Curb and Gutter Designs

97 Per Cent Reduction of Pollution by Private Industry

Cooperation between industries and State health and municipal sewer departments in the treatment of the industrial wastes is becoming commendably common, to the credit of all concerned. Perhaps the greatest credit earned by any of them is due to the Corn Products Refining Co., of Chicago. According to Wm. H. Trinkaus, acting chief engineer of the Sanitary District of Chicago, this company "has established what is probably a world-wide record in reduction of industrial waste pollution"—a reduction of 97% of the oxygen demand, which "is probably greater than would be obtained by any practical process of sewage treatment on such wastes."

The first step taken by the company, completed in 1925, comprised the removal of insoluble solids from the wastes by a system of more efficient settling and more careful control of settling processes, resulting in a decrease of population equivalent from 370,000 in 1923 to 260,000 in 1925. The second step, inaugurated in 1926, was the remarkable process of "bottling-up," by which the soluble solids were increased to a concentration where it paid to evaporate the liquor and sell the solids for stock feed. This process was inaugurated in September, 1926, and the following year the population equivalent dropped to 77,000. From 1927 to 1935, inclusive the equivalent has been as follows:

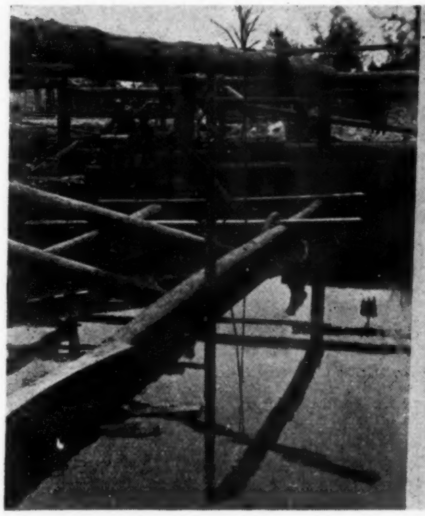
Year	*Population Equivalent*
1927	77,000
1928	56,000
1929	71,000
1930	63,000
1931	78,000
1932	63,500
1933	59,000
1934	91,000
1935	60,000

In 1935, intensive work was started toward the third step in the program of elimination of wastes, namely, removal of volatile solids, i.e., those solids given off from the steep-water when it is evaporated. These volatile solids were carried over into the water used in a barometric condenser and thence to the sewer. Likewise, condensed vapors from a triple-effect vacuum pan were discharged to the sewer. The nature and importance of these losses were pointed out to the Corn Products Company officials by the Sanitary District. In 1935 the company started research toward elimination of the volatile solids from the wastes discharged to the sewer. The results of the various schemes were determined by b. o. d. determinations made in the laboratories of the Sanitary District. After it was determined that substantial reductions could be made along the lines under investigation, the Corn Products Company purchased equipment for handling the entire wastes from the plant, and installed it during the early summer of 1936.

The population equivalent of the wastes for 1936 were as follows:

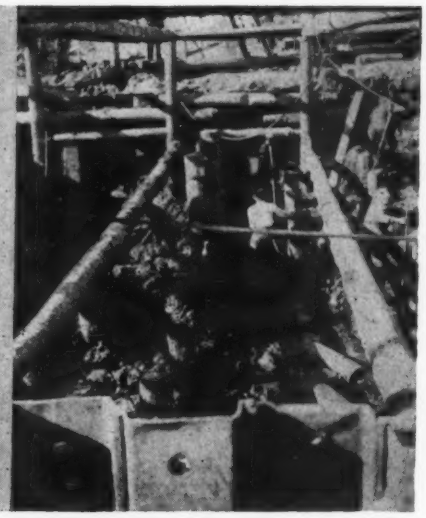
January-June	34,000
July-November	22,000

By this process of further recovery, the wastes have been reduced to what appears to be the practical limit of recovery within the factory. Without any of the three steps of recovery, the wastes for July to November, 1936, would have had a population equivalent of 372,000 based on the average grind for that period. A residual of 22,000 amounts to only 3.0 per cent, in other words, a reduction of 97.0 per cent has been effected.



Failure of ordinary dewatering methods

Type of material excavated, showing lateral movement



Excavating before lowering ground water

Sewage Treatment Plant Construction in Treacherous Ground

O. J. SEMMES, Jr.
City Engineer, Pensacola, Fla.

AFTER two and a half years of negotiation with PWA for a loan and grant for construction of two sewage treatment plants, the City of Pensacola, Fla., abandoned its efforts and made application to WPA for construction of them. This was promptly arranged and within two months construction work had started.

The sanitary sewerage of the entire city is divided into two drainage areas with outfalls about one mile apart. At the westerly outfall a plant consisting of coarse screens, clarifier, chlorinators, recording weir, and pneumatic sludge ejector, has been practically completed. This plant is designed for 0.9 mgd. The sludge from this will be pumped through a 4-inch force main to the easterly plant.

The easterly plant has a comminutor, clarifier, chlorinator, recording weir, sludge pumps, and two-stage digestor with gas holder on the secondary digestor. This plant is designed for 1.7 mgd.

The only available site for the easterly plant was a low swamp which had served as the slab dump of an old saw mill. The top ten feet of this ground was composed of peat and other vegetable matter. The next ten feet was a fairly stiff muck. At twenty feet down there was fine sand. This presented a problem in giving an adequate foundation for the plant structures. To effect this, the design called for supporting them on bearing piles placed on 6-foot centers and driven well into the sand.

The bearing piles were driven in advance of the excavation. Immediately upon completion of this driving, a cofferdam was built surrounding the site to be excavated. Round piles 35 feet long were driven, and behind these, 12-inch wales were placed, and against them, steel sheet piles 16 to 20 feet long were driven. The top of the ground was elevation 2.0 and sub-grade was —10.0, and the cofferdam sheet piling was driven so that the tops of the piles were at approximately 0.0, which gave them a minimum penetration of 6 ft. in the stiff mud, which was thought to be ample.

After the completion of the coffer dam, excavation was carried to approximately —8.0 with little difficulty with water or appreciable movement. After that the fun started. The quicksand began to find its way up along the previously driven bearing piles; then the ground next to the cofferdam began to move and a general subsidence of the surrounding surface was noticed. After a week of this, the cofferdam began to move in on the excavation. No amount of bracing seemed able to hold it and nearby structures became endangered. It was apparent that some radical modification of the construction procedure was necessary.

At this point a council of war was held and the City Council was persuaded to make an additional appropriation for the work. The only remedy for the situation seemed to be to lower the ground water, relieving the pressure and solidifying the soil, and a Moretrench well-point system was ordered by telephone and was in operation in less than ten days.

In installing this, a six-inch mainfold was laid around the entire excavation and about fifteen feet outside it. Well points were jetted down at five-foot intervals, the sinking of the points being conducted in such manner as to insure a large hole around them, which hole was filled with coarse sand. These were connected to the mainfold, and this to a pump.

Two days after beginning operation of the well points, excavation was resumed, and since that time no further lateral movement has been observed. Subsidence in the immediate vicinity has continued, due to draining the peat, but this has had no bad effects on any improved property. After the installation of the well-point system, construction has been carried on as though the entire structure were above the water

The pump that kept the water down

6" manifold with well points at 5' centers

Construction on predrained bottom at —10.0

table. The well-point pump was operated continuously and pulled about 900 gpm. with 20-inch vacuum. Although the excavation was carried to —10.0 elevation and was within 500 feet of the shore line, the water pumped was apparently fresh after two months of pumping.

The well-points have now been withdrawn and returned to their owner and the Pensacola sewage treatment plants are well on their way to completion. They will probably be in operation in less than a year after application was first made to WPA. The work has been of such a nature as would make any contractor stay on his toes, but within two months WPA will have brought it to a successful completion.

The plants were designed by Weideman and Singleton, consulting engineers, of Atlanta, Georgia. Supervision of construction has been by the writer. W. G. McDonald was superintendent on both plants for WPA.

Charging Sewer Rentals Held Valid

The village of Lewisville, Ohio, for about 25 years has maintained a sewerage system and sewage disposal plant. Finding that its revenue from general taxation was insufficient to maintain its various functions, and as an emergency measure, the village passed an ordinance providing for rental charges to be paid by the owners of property served by connections with its sewage disposal system. Suit was brought by owners served to enjoin enforcement of the ordinance on the ground that the charges were unlawful as assessments against the lots. The Ohio Court of Appeals held, Grim v. Village of Lewisville, 6 N.E. (2 d.) 998, that the charge made was not a special assessment, but a rental specially authorized by the Ohio General Code section 3891-1, partaking of the nature of a tax or assessment, and the ordinance was valid as the exercise of a statutory right to collect such rent.

Garbage and Refuse Collection and Disposal in Wisconsin Cities

Summary Based on City Surveys Conducted by League of Wisconsin Municipalities During 1936

Class of city (pop.)	*Over 27,000*	*10,000 to 27,000*	*4,000 to 10,000*	*Under 4,000*	*Total*	*% of all Cities Having Service*
Number in class	*10*	*16*	*29*	*90*	*145*	
Garbage collection service	10	14	14	28	66	
Free	10	10	9	22	51	76 %
Fee charge	0	4	5	6	15	24 %
All season service	9	13	11	25	58	92 %
Service for part of year	1	1	1	3	6	8 %
Collected by city forces	9	4	3	16	32	51 %
Contracted to private collector	1	7	7	4	19	27 %
Private collector contracts with individual taxpayer	0	3	4	8	15	22 %
Cities without above service in any form	0	2	15	62	79	....
Percentage of cities without service	0	13%	51%	68%	54%	of all cities
Rubbish collection	9	5	19	75	108	100 %
Weekly collection	4	4	8	20	36	34 %
Monthly collection	4	0	1	3	8	6.6%
Semi-annual collection	0	0	1	6	7	6 %
Annual collection	1	1	9	46	57	53.4%
Cities without above service in any form	1	11	10	15	37	....
Percentage of cities without service	10%	68%	34%	16%	25%	of all cities
Means of disposal	10	14	20	76	120	100 %
Dump (refuse and garbage, or either)	4	7	18	62	91	75 %
Incinerator (refuse and garbage, or either)	5	0	1	0	6	4 %
Incinerators in business district	0	0	1	1	2	1.7%
Garbage as feed (for hogs, etc.)	1	7	8	13	29	25 %
Cities without above service in any form	0	2	9	14	25	....
Percentages of cities without service	0	12½%	31%	15½%	17%	of all cities

The Editor's Page

That American Water Works Association Convention

June, to the poets, is the month of brides, roses, etc., but to the engineer and waterworks superintendent it is the month of the American Water Works Association annual meeting. This year, the meeting is to be held in Buffalo.

That it will be instructive and enjoyable goes without saying, for the AWWA has been uniformly fortunate in its conventions. They are well arranged and scheduled; the programs contain many excellent and worthwhile papers and discussions; and the entertainment features far surpass those of any other convention that we are familiar with. Mainly with water works talent, they are interesting, refreshing and, in themselves, a real reason for attending the convention—apart from the technical side of the question.

This will be the first convention under the direction of Harry Jordan. Advance reports regarding registration and attendance indicate that it will be the biggest and best ever. No one should miss it. We hope to see you there.

Sanitation—What Publicity Crimes Are Committed in Thy Name!

Frequently we are in receipt of a communication from a more or less indignant water works superintendent or engineer, enclosing material published in a local paper under a head such as "Business Developments," which attempts to sell to the public householders filters or sterilizers, softeners, or other equipment. One, an "argument" for water softening, lies before us. Some of the statements it contains seem to assume a credulity which we doubt if many, even of the most technically uninformed, would possess. For instance: "All hard water is impure; pure water is absolutely soft. Pure water is a chemical curiosity. Water is the universal solvent—it dissolves even diamonds, glass and iron. Absolutely pure water is impure, that is, it contains mineral impurities. . . . If we knew the food we were eating was impure, that it carried a great amount of impurities, we would do something about it; therefore, isn't it strange that so many of us accept water just as we find it and do not make any attempt to purify it. . . ." And so on, for a couple of columns, much of it even stronger in condemnation of the local water, with the aim of "selling" the public a certain water softener.

The man in charge of water works is liable to resent such implications on his water supply, especially when it is actually an excellent supply (as this one is), though perhaps hard. It seems to us that manufacturers might find it very wise to restrain the enthusiasm, and improve the understanding, of their agents, and that working with the superintendent would more often produce results than criticizing conditions over which he often has no control.

The Barkley-Vinson Bill

Unless economy measures interfere, the Barkley-Vinson bill is likely to pass Congress during the present session. This bill provides for a definite national policy in the matter of stream pollution and lays down a procedure whereby the States will be encouraged and aided in reversing the pollution trends of past years. Naturally, this involves the expenditures of money for the treatment of municipal and industrial wastes. In many respects, this bill would provide for aid to the States through the State boards of health after the plan that furnishes aid for highways through the State highway departments.

Public Works is intensely interested in this measure, as the best means of beginning a big and vitally needed job. It is further interested because of the fact that in the issue of January, 1935, its Editors laid down the basic principles to be observed, outlined the need for action, and suggested a plan of procedure. That article was prepared after consultation with leading engineers. It was, we believe, the first openly to advocate government assistance. The reaction of the proposals in that article brought forth many favorable comments. The article itself was incorporated, in whole or in part, in recommendations which have resulted finally in the present action.

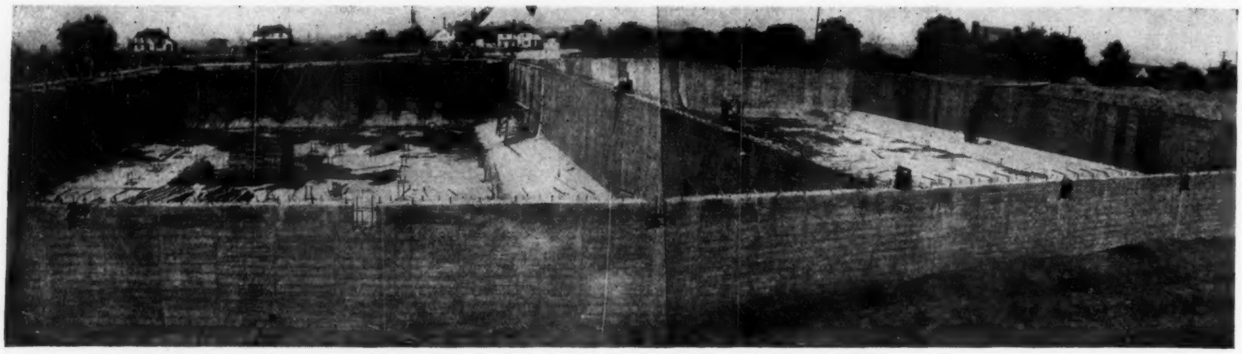
Prevention of further stream pollution and the cleaning up of streams now badly contaminated is one of the most important conservation problems of our time, and one in which the returns on the money spent will be greater, to the whole nation and to the individuals of the nation, than is possible in any other way.

More Motor Vehicles Require More Improved Road Mileage

During the depth of the gloomy times of 1933 and thereabouts, the prediction was freely made that the number of automobiles and their gross total mileage would never increase much, if any, beyond the figures of 1930. Since that time, the number of privately owned motor vehicles has increased 6%, and those owned by federal, state and local governments have increased 70%. The increase in privately owned vehicles alone means something like a million and a half more vehicles on the roads.

If highway traffic could be regulated like railroad freight traffic and spread evenly throughout the 168 hours of each week, there would not be so much reason to worry about traffic jams; but the motorist goes, and always will go, when and where he wants to. From the road builders' viewpoint, this means that roads must be provided to care for all the traffic that may come on them—within reason; not every rural road can be expected to take the heaviest truck, or to provide for totally unexpected and unusual traffic congestion.

All of this means that the idea that road building had reached its limit must be put aside and our highway systems must continue to expand through the construction of all-weather roads to carry this increased and increasing traffic. Fortunately, the financing of highway construction has been simplified by the gasoline tax, or it would be simplified if the gasoline tax were used for highway construction and maintenance only, and not diverted to numberless other and unfair uses.

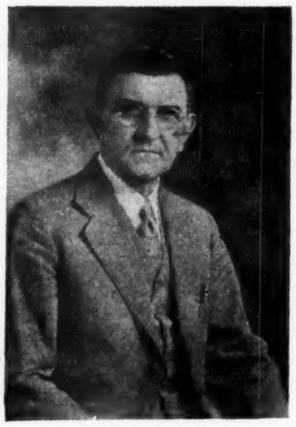


General view of reservoir. Roof construction begun at left.

Development of Middletown's Efficient Water System

By EARL GEBHART
Superintendent of Water Works, Middletown, O.

MIDDLETOWN, Ohio, has from the beginning been very fortunate in the matter of its water supply, especially in the quality thereof; in quantity also at first, but not in recent years. The entire Great Miami Valley, in which it lies, has a wonderful underground supply of pure, clean, sparkling water. A porous stratum, about 40 ft. deep in the low lands near the river, underlain with impervious hardpan, furnished a supply of such water which for many years seem abundant.



Earl Gebhart

The city's water works began in 1875 with a Holly system. One 4-cylinder pump, turbine driven with a 16 ft. head from forebay to tailrace, pumped water from an open well (long since abandoned) 25 ft. diameter and 35 ft. deep walled up with stones, discharging directly into the distributing system, without any storage or reserve of any nature. The population then was less than 4,000.

As the town grew, extensions were made, but no major improvements for 30 years. Finally in 1905, with a population increased to 11,000, it was found necessary to provide additional equipment. By 1915 the population had grown to 16,000 and it was again found necessary to increase the equipment, and also larger mains. The consulting engineers in charge of this improvement estimated that this would suffice for a population of 30,000 to 35,000, and that this would not be reached before 1965. This forecast was very much wrong for the 1930 census showed 30,000 population.

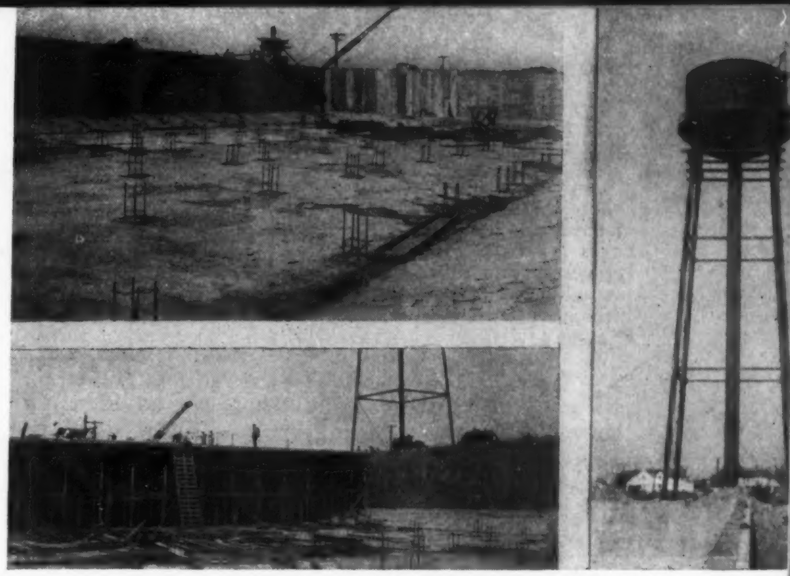
Floor reinforcement.

During this time, no important improvements were carried out; only piecemeal extensions of the distribution system to meet the immediate needs of newly annexed territory. No comprehensive or foreward looking plans were made, the idea seeming to be to struggle along as well as possible until an emergency necessitated some major improvements, after which things were again allowed to drift until the next scare came. The well system consisted of driven wells approximately 45 ft. deep resting on hardpan, located in the low land close to the river and just at the edge of the city. Within about four city blocks of the wells are located six large paper mills which draw enormous amounts of water from the same stratum through their own more modern wells, and the combined draught on this water source is so heavy as to give the members of the water department deep concern. In fact, it created another emergency just a few years ago and necessitated planning to locate a source of more abundant supply. Since this surface supply is dependent directly upon the territory tributary to it, the apparent lessening of that available for the city must be due to two main factors: the natural lowering of the water table noticeable in many sections of our country, and the enormous and seemingly increasing amounts withdrawn for manufacturing purposes. The first thought was deeper wells. It was reported that this was tried many years ago and the water found to be not fit for public use, and this opinion had become deeply rooted in the minds of the people. But as the need was desperate and there seemed no other recourse, it was decided to try it.

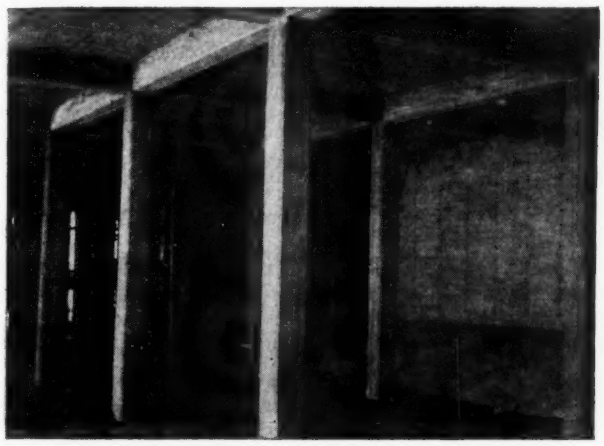
Surprisingly, what seemed to be an abundant supply of excellent water was found—practically the same

quality as that already in use except that it carries a much higher iron content (which at some time in the near future will present the problem of iron removal). Wells of the gravel wall type were driven to a depth of 185 ft. through 40 ft. of impervious hardpan and turbine deep well pumps, electrically driven, were installed. The problem of inadequate pumping facilities was met by adding three centrifugal pumps direct-connected to electric motors.

This was in 1934. And now, with 30,000 people to supply, the distribution system stepped into the center of the stage as the creator of more sleepless nights. The accompanying chart shows how the demand jumped up during a typical dry, hot summer day. During this peak period every available piece of equipment was pressed into service and worked at top speed. What would have happened had a fire demand been added was a serious question; the fire chief and I agreed that in case of fire he would notify the water department at once, and all available water would be diverted, if necessary, to the fire zone by closing of valves. In this emergency Allensworth & Burgess were engaged as engineers and prepared plans and specifications for a 4 mg. covered concrete reservoir and



Above—Concrete floor, with post reinforcements. Below—Forms for roof and posts. Right—Elevated tank.

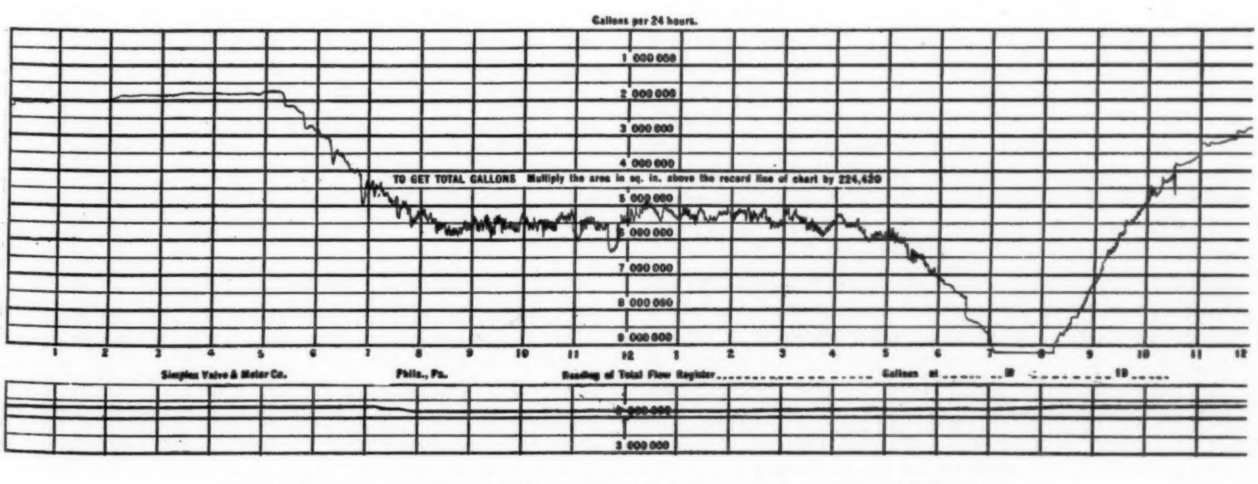


Interior of reservoir. Roof and supporting columns completed in the foreground.

100,000 gal. elevated tank. The reservoir is 213 ft. long by 184 ft. wide and 16 ft. deep, divided into two equal parts by a wall provided with a gate so that the valves can be operated separately or jointly. Fortunately a site was obtained suitable for its location from a distribution standpoint, its accessibility and of exactly the desired elevation. The tank rests on 4 columns 100 ft. high with high water level 130 above the ground. It is supplied by two 300 gpm. direct connected centrifugal pumps, automatically regulated by two Minneapolis-Honeywell mercury switches; one pump cutting in at 48 lb. and out at 52 lb., the other cutting in at 52 and out at 58. This tank serves a high-service district which previously had been supplied by two electrically driven centrifugal pumps pumping directly into the mains with no reserve of any kind, so that one pump had to operate continuously. Now one pump operates about 8 hrs. a day, giving great saving in electrical energy. A liquid level indicating and recording gauge gives the water level in the reservoir, operating over 2½ miles of the police call wires.

The plans called for a chlorinator and ammoniator, but these have not yet been installed, as most of the citizens feel this treatment to be unnecessary because the analyses have never shown any sign of contamination of this supply and the chances now are no greater than before. However, the State Board of Health holds that there is contamination hazard in the well field in the nature of a large open gravel pit and a sanitary sewer and insisted on the inclusion of chlorination in the plans.

The work was done with PWA labor, the city furnishing all materials. City Engineer L. P. Diefenbach and staff were in direct charge of the work, which began in December, 1935, but was soon stopped by cold weather, was renewed in April, and the reservoir



Demand curve at peak load before and after changes in the system at Middletown.

filled on September 10. The total cost was as follows:

Total Cost of Project

Labor (P.W.A.)	$ 38,818.15
Materials	53,388.84
Lands	5,000.00
Engineering and consulting	4,499.93
Interest during construction	1,259.99
Preliminary expenses	68.33
Printing, advertising, general overhead, & miscellaneous	382.40
	$103,417.64

The operating economy of the recent additions is shown by the accompanying charts. This economy is necessary if the present low rates are to be continued. These rates are: First 1,000 cu. ft. or less per quarter, $1.25; next 4,000 cu. ft., $1.00 per M; next 5,000 cu. ft., 90 cts.; all over 10,000 cu. ft., 60 cts.

The history of this plant prior to 1930 illustrates the writer's opinion that any major waterworks project should be planned to meet the needs for many years in the future; all additions and extensions that are carried out from time to time being so planned and constructed that they eventually will fit into the final picture and become as one with it.

The City Commission which carried out this improvement were R. A. Gibbs, Earl Grant, Edward Kramer, Thomas Baird, with J. W. Holman, chairman. Walter J. Braun was city manager.

Corrosion Testing Procedure

IN a paper on "Principles of Corrosion Testing," before a regional meeting of the American Society for Testing Materials, C. W. Borgmann and R. B. Mears classified the various types of tests into three broad groups: (1) laboratory; (2) field; (3) service. After a brief review of the theory of corrosion (the authors adhered to the electro-chemical theory) they discussed the various methods of estimating the rate of corrosion and the extent of corrosion, stressing the advantage of "special property" tests over "accelerated corrosion" tests. Of the five main aims of corrosion tests, the study of mechanism of corrosion is most basic. The authors listed certain tests on which, in their opinion, sufficient data are available to justify standardization. These were divided into laboratory tests (impingement attack, intercrystalline corrosion, corrosion-fatigue, partial immersion tests, spray tests, etc.), and field tests, including atmospheric exposure, soil corrosion and immersion tests. Tests which seem to require further work before standardization, under the general heading of laboratory tests, included stress corrosion, film breakdown tests, crevice tests, total and alternate immersion tests, and dezincification of brass.

Dr. H. S. Rawdon in discussing "Atmospheric Corrosion Testing," outlined methods and precautions used in conducting the tests, confining his comments largely to field tests. Results of exposure tests should always be correlated with prevailing atmospheric conditions and a close distinction must be drawn between tests aimed essentially to develop chemical characteristics and those intended for the acquisition of engineering corrosion data. A relatively large surface area with respect to the mass of the specimen was listed as always advantageous. Doctor Rawdon stated that the change in ductility is a more sensitive indicator of the effect of corrosion than the accompanying change in tensile strength.

In their paper on "Salt Spray Testing," E. H. Dix, Jr., and J. J. Bowman stated that results are of substantial value when properly interpreted. For comparison of similar materials or as an acceptance test for certain classes of materials, the test has much to recommend it, while for comparisons of radically different materials or as an accurate indication of service life in other than marine atmospheres, its use may be hazardous. A study of summaries of many corrosion tests of aluminum alloys led to the conclusion that the salt spray test is a reliable method for comparing aluminum alloys and can be used, in combination with practical experience, in estimating the service life of these materials. The authors pointed out that to secure the best results from the salt spray test, standardization of operating procedures appeared desirable.

Rather extensive uses of the "Alternate Immersion and Water-Line Tests," were described by D. K. Crampton. The alternate immersion test is carried out by dipping specimens in and out of the solution at a definite rate. It was indicated that the results obtained with the test had indicated relative rates of corrosion of several alloys which were nearly in line with the behavior under generally similar service conditions.

K. H. Logan, S. P. Ewing and I. A. Denison in their very extensive paper on "Soil Corrosion Testing," stated that the subject fell into two main divisions: (1) the influence of the nature of the metal and (2) the influence of the soil. A study of the corrosion of various metals in soils is largely a study of the properties of the soils which are important in corrosion. The authors pointed out that every soil condition is in a sense unique and that the rate of corrosion cannot be predicted in the absence of knowledge of the properties of the soils. From an analysis of data obtained from three sources (1) service data on pipe lines, (2) field burial tests of selected metals, and (3) laboratory tests, the authors stated that it should be possible to devise a procedure to determine the corrosiveness of soils and express it in acceptable units.

A rational procedure for testing the corrosion of metals in soils involves: (1) the corrosiveness of the soil; (2) the relation between pit depth and area; and (3) the relation between pit depth and time. By means of an equation in which the depth of the deepest pit on a given area is expressed as a function of (1) the corrosiveness of the soil, (2) the area exposed, and (3) the period of exposure, the estimated depth of pit may be calculated to the desired area and time. A general equation was given for the estimation of the number of holes, if any, in pipe as a function of the corrosiveness of the soil, time and wall thickness.

Advertisement for Bids by Villages Required

An incorporated village of New York, owning its own municipal water plant, asked for bids for a new well and pumphouse from four firms. It accepted a bid, not the lowest, from a firm which had already supplied the village with a well and pumping equipment. In an action for temporary injunction of any contract based on such bid, the New York Supreme Court, Trial Term, Nassau County, 293 N.Y.S. 457, held that the Legislature intended by the addition in 1934 of section 26-a to the New York Public Works Law to bring about public advertisement for bids for all public works of any character in any part of the state for any purpose. The section requires that "contracts for public work shall be awarded by any board, officer, agency, department or commission of the state or any political subdivision thereof, or by any district contained therein only after advertisement for bids," etc. Temporary injunction was granted.

35 Practical Suggestions for Sewage Plant Designers

THE Illinois Division of Sanitary Engineering, C. W. Klassen, chief sanitary engineer, issues a quarterly "To promote the installation and efficient, economical operation of sewerage systems" which contains good, live, practical suggestions for superintendents of plants which must certainly be of great value in effecting that purpose. Our congratulations to "The Digester," which is edited by W. H. Wisely, assistant sanitary engineer.

The May issue contains an article under the title "Plant Pet Peeves" which well illustrates the value of the information published and which should not only have more than state-wide circulation among superintendents, but also and especially should be read and considered carefully by engineers who design plants. The article is quoted in full below:

In the February issue, we asked for comments concerning the features of your sewage treatments works which are important from the standpoint of plant operation and which could have been improved upon in design. Response was excellent. (Wish it was as easy to get ordinary contributions as it was to get these!)

Our object is to learn more concerning plant details, which information we can pass on to designing engineers. To avoid embarrassment to anyone, we shall name no names of plants or individuals and offer herewith a "digest" of the survey, presented as your suggestions to designers:

General

1. Make all channels self-scouring. Provide *tight* stop gates to completely cut out all channels not in continuous use.
2. Place all underground valves in manholes.
3. Include a portable power pump in specifications.
4. Provide ceiling vents in all buildings and pits.
5. Provide electric outlet plugs at convenient points where emergency service might be needed.
6. Specify water supply appurtenances of the same manufacture as used in the public water supply to facilitate repairs and replacements.
7. Avoid steep terraces.
8. Provide ample laboratory space and some laboratory equipment.
9. Provide a toilet in the service building.
10. Provide drains under sampling cocks.
11. Keep the plant above high water stages in the outlet stream.

Screen Chambers

1. Allow adequate room to handle a long rake.
2. Provide a wall-ladder into deep chambers.

Grit Basins

1. Place ahead of pumps where possible.
2. Provide for dewatering of channels during cleaning.

Pumping Stations

1. Don't provide vitrified pipe lines as pump suctions.
2. Slope wet well floors to sumps at the pump suctions.

Settling Tanks

1. Make all baffles and weirs adjustable and accessible. (A slat-shutter type baffle is suggested by one operator.)
2. Provide at least 2 units if at all possible.
3. Make provision for quick and easy sludge sampling and inspection.
4. Provide individual valves on each sludge suction where there is more than one hopper.

Trickling Filters

1. Provide threaded two inch plugs in the ends of all distribution lines (where laid at the rock surface) to facilitate flushing.
2. Provide for bleeders to eliminate freezing in distribution systems.
3. Provide a one inch mesh screen (removable) to remove nozzle and orifice clogging material from the settled sewage.
4. Don't specify rock that is too small.

Sand Filters

No comments received. These must all be perfect!

Activated Sludge Units

1. Provide flexibility in return sludge pump capacity.
2. Make sludge division boxes so that adjustment is convenient.
3. Eliminate excessive water surface fluctuation in aeration tanks.
4. Provide a separate power meter for the aeration equipment.

Sludge Digestion Units

1. Be liberal in capacity and provide at least two units even if one is an open storage tank.
2. Provide for convenient supernatant liquor sampling at several levels.
3. In heated tanks, be sure that heating facilities are adequate.
4. Make gas lines at least 2½ inches in diameter.

Sludge Drying Beds

1. Make provision for easy draining of sludge lines after each use.
2. Too much freeboard above sand surface should be avoided. Sixteen inches suggested as maximum.

There they are—35 items in all. But it could have been worse, couldn't it? Sorry we had to omit some of the "personal" ones.

Occasionally Mr. Wisely or some anonymous author breaks out into poetry. Here is a sample:

The Sewage Bug—Long May He Slave!

We "sewage men" should not disdain and nonchalantly shrug
When credit is accorded our good friend the "sewage bug."
No bugs—no trickling filters—no activated sludge—
No digesters to change foul stuff to black and tarry fudge.
Why, many sewage treatment plants would not be worth a hoot
If we didn't have those little bugs to get in there and root!

Our job's to keep them healthy and fit to do their work
And if we just do our part right, the bugs will never shirk,
The temperature, pH and food and oxygen controls
Must be maintained with vigilance. These bugs are choosy souls!
Sometimes it nearly drives us "bugs" to keep the bugs content
But when we do, it shows up in the treated effluent.

We see and hear and read a lot about the operator.
How *he* does this and *he* does that as trouble terminator.
But when you get right down to facts, here's one you can't deny—
Our plants would fail without the bugs, no matter how *we'd* try.
We need the bugs and they need us in our strange occupation.
The answer sums up in one word. That's right—COOPERATION!

Jobs That Bulldozers and Trailbuilders Can Do

An "Angledozer" cuts a trail along a steep bank.

BULLDOZER and tractor equipment is valuable in dirt-moving, but also has a variety of other uses in city, county and town work, the extent of which is often not realized. These uses include many operations incident to highway construction and maintenance, such as cutting off banks and widening curves; making fills; backfilling over culverts; working with and cleaning up around power shovels; moving gravel to crusher or screen; cutting close to final grade; taking out brush and stumps; and, of course, dirt moving for distances up to 200 or 300 feet.

Non-highway uses include backfilling trenches; leveling and covering refuse dumps; snow-plowing; stripping brush, top soil and sod; spreading and compacting on dams, embankments, fills, etc.; and leveling in parks, playgrounds, and similar areas.

A bulldozer, as shown in many of the illustrations that accompany this article, consists of a movable blade that is mounted on and pushed ahead of the tractor. The blade can be raised or lowered, but is movable only up or down. A variation of the bulldozer is the trailbuilder, in which the frames holding the blade are so arranged that the blade can be angled horizontally in either direction for casting material to the side; can be angled vertically for limited grading and finishing; and can be moved up and down in the same manner as the bulldozer blade. It thus is useful for certain varieties of work that the bulldozer cannot perform.

The blade area—the product of its length and depth—must bear a relation to the weight and power of the tractor. The trailbuilder blade must be wider than the bulldozer blade, so that when used at an angle it will still be as wide as the tractor. To compensate for this, the blade is usually shallower than the bulldozer blade and will handle a less depth of material on a straight push forward. The advantage of the trail-builder is in its ability to backfill trenches, move material sideways, do some grading, and also perform other work that the bulldozer can not do.

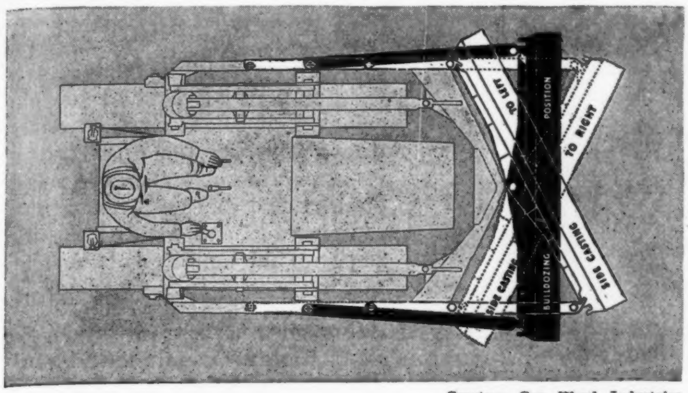
Trailbuilders are made by a number of firms, all of which have special names for their products. Le Tourneau has the Angledozer, and also the Treedozer, especially designed for removing brush and trees; Bucyrus-Erie, the Bullgrader; Baker, the Gradebuilder; and Wood the Roadbuilder. All these firms make bulldozers also, as do Euclid. La Plant-Choate, Blaw-Knox, Bros., Heltzel and Continental. Both bulldozer and trailbuilder are available in a variety of sizes, generally for tractors of 30 hp. and up.

The special equipment, such as the trailbuilder, costs from 20% to 30% more than the bulldozer and is preferable for all-around work such as is usually found in city, county and town work.

In Dirt Moving

D. A. Milligan of the Cleveland Tractor Co., in his excellent booklet on earth-moving (published by that company), states that bulldozers and trailbuilders will handle dirt more cheaply than any other equipment,

Cleveland tractor and Wood Roadbuilder making a cut at the left, and rooting out stumps at the right.



Courtesy Gar Wood Industries.

This shows some of the blade variations possible with the trailbuilder type.

up to 200 or 300 feet; and they are also useful on side hill work, in leveling dumped material, on balanced and close together cuts and fills, and on moving boulders and blasted rock. In firm dirt, he states, the FG or FD Cleveland tractor (93 h.p.) and appropriate bulldozer or trailbuilder will move 70 cubic yards an hour on a 100-ft. haul, 40 yards per hour on a 200-ft. haul, and 25 yards an hour on a 300-ft. haul. The 60 h.p. tractor and smaller equipment will handle about 70% as much; the 45 h.p. unit, about ½ as much; the 35 h.p. models will handle about 24 yards per hour on a 100-ft. haul and half as much at 200-ft. Beyond this distance, the smaller units are not economical. In leveling fills, the above capacities in yards per hour are increased considerably; also in down-hill work.

All data of this type must be used for general guidance only. The type of soil, efficiency of operators, up or down-hill operation and other factors will influence the results materially. It will also be noted that the size of the unit affects the cost, the larger outfits naturally doing the work at a lower unit cost.

Other Highway Construction and Maintenance Uses

On cuts even up to 20 ft. deep, where the material need not be moved more than about 250 feet, a tractor-bulldozer unit can do all the work with one operator—cutting to grade, moving dirt, leveling and tamping the fill. Such work is particularly valuable on rural roads in reducing short, sharp grades. In widening work, the bulldozer can take dirt from a bank at one side and desposit it as a fill on the other. Sight distances around curves can be lengthened and alinement improved in the same manner.

Bulldozers or trailbuilders can handle large rocks by bulldozing, that is, pushing straight ahead; and they can handle blasted rock or rock that has been broken up with a rooter or heavy plow. Where the haul is short, this is perhaps the most efficient method of handling—as where a sidehill road is being widened.

On long hauls where trucks or large wagons are being used to convey dirt to a fill, the bulldozer levels the dump and also compacts it. The layers can be spread as shallow as desired. If added compaction is desired, a sheepsfoot roller can be attached to the rear of the tractor, which thus spreads and compacts thoroughly in one operation.

The trailbuilder was developed largely for the purpose of opening new roads in steep areas. A notch is cut with the blade along the desired grade, this being wide enough to provide footing for the tractor. In subsequent operations, the notch is widened, as desired,

Above, using bulldozer to clear brush, grass and top soil. Below, leveling a refuse dump with caterpillar and bulldozer.

the dirt being spilled over the down-hill edge. This method can be used also for building trails to camp sites, through parks, to reservoirs, logging camps, and similar places.

Stumps can be removed with either the trailbuilder or the bulldozer, but the former is most efficient because the blade can be raised so that power can be applied at the top of the stump for uprooting, or below, as desired. Brush can be removed readily with the standard equipment, and pushed off the right-of-way.

On shovel cuts, a bulldozer can handle rocks too large for the shovel, and is useful in keeping a way clear for

Tractor and angledozer on Birmingham water supply project, filling pipe line ditch and constructing road.

Cleveland tractor and trailbuilder backfilling a trench.

the hauling units, and also in leveling a path in advance for the shovel, thus speeding up the work. These units can also be used on steep ground for cutting an approach for the shovel and a hauling road, often permitting a cut to be made in a single lift which, if ordinary methods were followed, would require 2 or 3 lifts.

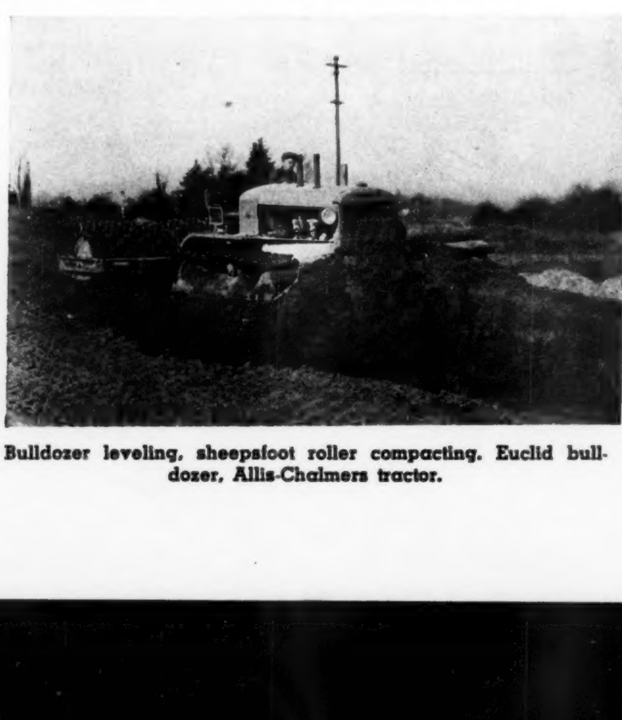
In gravel pits, the bulldozer may be used to push material to the loaders, sometimes taking the place of a small dragline. It can also be used on various road maintenance work, especially in spreading material on shoulders, and in scraping mud, ice or other material from the road surface.

General Uses

Many cities use bulldozers to level refuse fills. If a bank of earth is available within a couple of hundred feet, the bulldozer can also bring in and spread the earth cover—which is desirable on every well managed dump. Other uses include backfilling trenches, old stream channels or other low places. For this work the trailbuilder is best.

The bulldozer or trailbuilder can be used as a snowplow, though this is recommended for emergency use only; and when snow has been windrowed or banked, as in a city, it can be used to cut openings for crosswalks, open up at hydrants, and pile for better and quicker loading. It is also handy for removing ice from street surfaces after it has been softened by calcium chloride, salt, rain or warm weather.

This equipment is particularly valuable on dam or reservoir work for stripping of sod, brush, etc., and piling to haul away; for spreading dumped material for dams, levees and embankment, and compacting it either through the operation of the tractor or of an attached roller; for piling the logs cut from trees removed in construction; and for dressing the slopes of the dam or embankment.



Bulldozer leveling, sheepsfoot roller compacting. Euclid bulldozer, Allis-Chalmers tractor.

Management on Grading Work

For most efficient operation, the bulldozer-tractor unit should work down-grade. When a trail is to be cut, the unit should, if possible, begin work at the top, along the highest point of the upper slope line of the proposed road. The dirt is pushed ahead, the tractor returning in reverse (as a rule) up the slope. A rather steep grade is desirable, as more dirt can be moved, and tractors can generally travel up a 50% slope.

Experience has shown that a load should be picked up, in grading or excavating work, within a length of 25 to 40 feet, with the tractor moving 2.0 to 2.5 feet per second. If the material is too hard to permit this rate of loading it should be loosened with a ripper or rooter or blasted.

To Find the Capacity of a Horizontal Cylinder

It is occasionally desirable to find the capacity of a cylindrical tank that is placed horizontally. The table below gives the data necessary. The figures given should be multiplied by the square of the diameter of the tank to find the volume for any depth *d* of the liquid; then multiply this result by the length of the tank in feet. The answer shows the number of cubic feet. To convert to gallons, multiply by 7.48.

	0	1	2	3	4	5	6	7	8	9
0.0	—	.0013	.0037	.0069	.0105	.0147	.0192	.0242	.0294	.0350
0.1	.0409	.0470	.0534	.0600	.0668	.0739	.0811	.0885	.0961	.1039
0.2	.1118	.1199	.1281	.1365	.1449	.1535	.1623	.1711	.1800	.1890
0.3	.1982	.2074	.2167	.2260	.2355	.2450	.2545	.2642	.2739	.2836
0.4	.2934	.3032	.3130	.3229	.3328	.3428	.3527	.3627	.3727	.3827
0.5	.3927	.4027	.4127	.4227	.4327	.4426	.4526	.4625	.4724	.4822
0.6	.4920	.5018	.5115	.5212	.5308	.5404	.5499	.5594	.5687	.5780
0.7	.5872	.5964	.6054	.6143	.6231	.6319	.6405	.6489	.6573	.6655
0.8	.6736	.6815	.6893	.6969	.7043	.7115	.7186	.7254	.7320	.7384
0.9	.7445	.7504	.7560	.7612	.7662	.7707	.7749	.7785	.7816	.7841
1.0	.7854									

Example: To find the volume of contents of a cylindrical tank 10 feet long and 6 feet in diameter, the tank being placed horizontally and the depth of material in it being 21 inches.

Solution: A depth of 21 inches equals $21 \div 60 = 0.35$ of the diameter of the tank. From the table, the factor for 0.35 is 0.2450. Cross-sectional area of the filled portion of the tank is $6 \times 6 \times 0.245 = 8.82$ square feet. The length is 10 ft., so that the contents in cubic feet equals 10×8.82, or 88.2 cubic feet, or 659.7 gallons.

Municipal Power Plant Makes Quick Profit

The new municipal power plant at Lyons, Colo., which has been in operation less than a year, has paid off the first $1,000 of purchase price and has made a profit to the city above that sum.

Plugging Dollar Leaks in Waterworks Systems

By ROBERT NEWTON CLARK
Sanitary Engineer with Floyd G. Browne

Reservoirs, and their watersheds, no matter how beautiful, need attention.

THERE are, without doubt, certain favored waterworks systems that are in an ideal state of repair and require no more than intelligent care to insure continued maintenance of that happy condition. There are, equally without doubt, many less favored waterworks systems that obviously, perhaps clamorously, demand repairs, improvements and alterations to render them fit for adequate service. Between these two extremes there are numerous systems which are operating more or less satisfactorily, with few outstanding needs for improvement but which, upon close scrutiny, are found to be suffering from economic anemia that can be traced in part to operating inefficiency.

Such a condition is not to be confused with inefficiency of management or of personnel, but is to be identified with general mechanical losses, or wear, or poor design, or occasionally to ignorance. In such a case, it is a good plan to make a periodic check of the entire system, and from this check to prepare a program of improvement or reconditioning based upon needs. To assist in that sort of a program, the following discussion of tests and studies may be of use, if only to call to mind factors that might otherwise be overlooked.

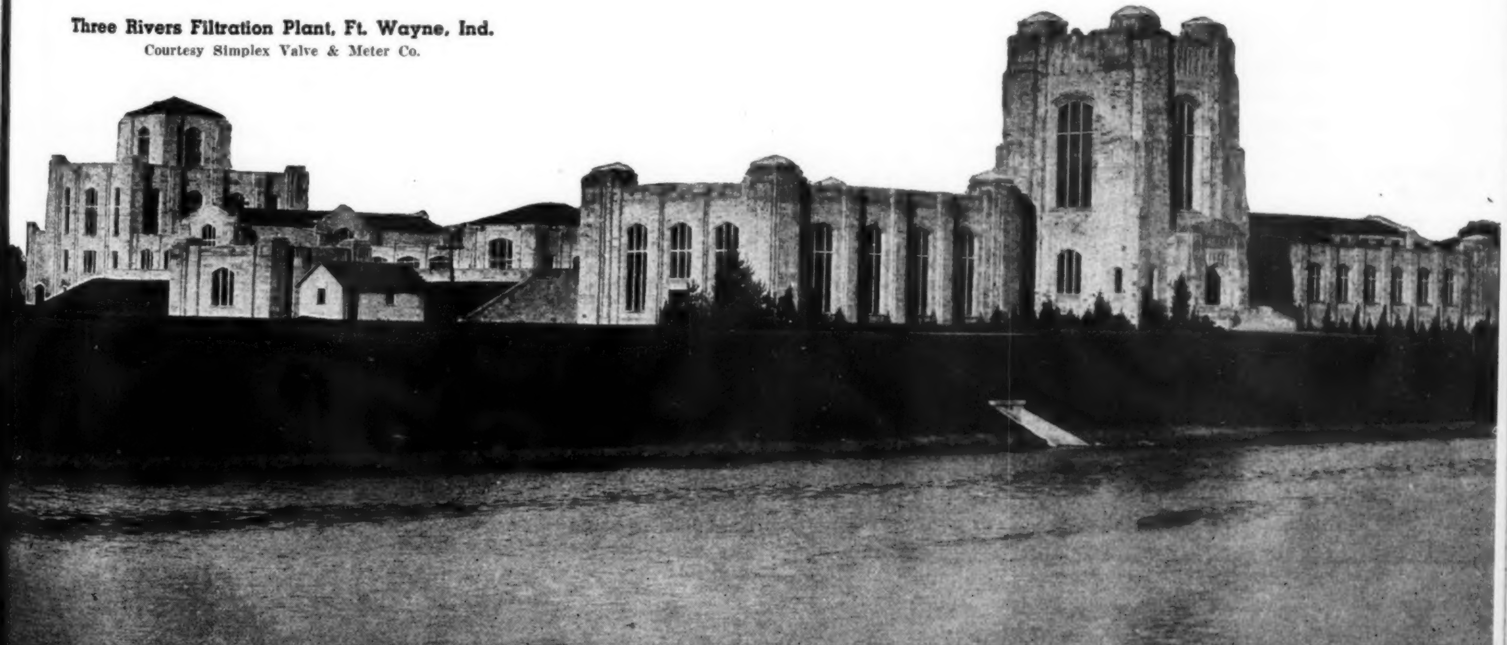
Since a waterworks system is not operated for profit alone, but to safeguard public health and safety, a checkup should not be confined to a purely economic study, but should keep in view the other equally important functions of service to the community.

Surface Supplies

Municipalities deriving their water from surface supplies are not permitted to overlook the sanitary condition of the tributary water shed, because of the constant watchfulness of public health authorities, and the same condition is true where natural reservoirs are used for storage. It is not amiss, however, to mention a sanitary survey as the starting point for a general system check.

The survey itself should be made by a competent and experienced authority, but it is a simple matter for a superintendent to make sure of the date of the last general inspection, and to judge as to the need of a present review of the situation. Along with the sanitary survey, it is frequently convenient to examine the condition of the storage basin or reservoir. Evidence of silting might be sought at the entrance points of streams or at mouths of gullies, and some thought given to the possibility of serious impairment to reservoir

Three Rivers Filtration Plant, Ft. Wayne, Ind.
Courtesy Simplex Valve & Meter Co.



capacity by reason of excessive sedimentation. A bit of planting frequently pays dividends by preventing bank erosion and reservoir silting.

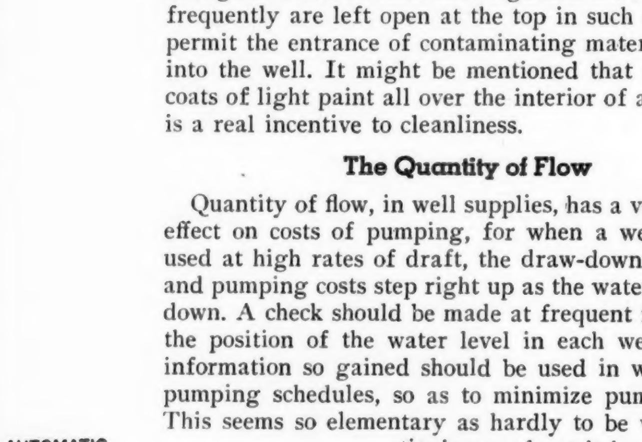
More serious, sometimes, is the problem of leakage from a reservoir. A leakage survey requires the exercise of experienced judgment to be worth the trouble of its making, but a short series of gaugings on all inflowing streams, with a check against the total outflow (not forgetting a pan of water to help estimate evaporation) will often indicate whether or not a leakage survey is needed. Leakage through or under a dam can be determined by comparing flows in the channel below the dam with spillway discharges, and frequently, if conditions are right, all spillway discharge can be stopped for a sufficient length of time to make the leakage estimate fairly exact. Excessive leakage appearing below a dam is a danger sign.

Another source of trouble, serious from the customer's viewpoint and expensive to correct if already present, is the growth of taste and odor producing organisms in a reservoir. A certain benefit follows a program of bank cleaning and elimination of stagnant areas, and this possibility might well be kept in mind during a reservoir inspection.

Sanitary surveys need not be confined to open water sheds, but can be applied with equal advantage to underground supplies. It is an excellent idea to sample each well at intervals, particularly after a prolonged period of wet weather, and make or have made a bacteriological analysis to determine the presence or absence of contaminating organisms. Most states maintain laboratories for exactly this sort of service. In any case, sources of pollution near a public well should be removed or rendered safe. Particularly dangerous are tile sewers or drains, and if any suspicion arises regarding the presence or condition of such a line near a well, no effort should be spared to safeguard the supply. Casings are sometimes cut off at a point low enough to allow surface drainage into a well, and very frequently are left open at the top in such a way as to permit the entrance of contaminating material directly into the well. It might be mentioned that a couple of coats of light paint all over the interior of a well house is a real incentive to cleanliness.

The Quantity of Flow

Quantity of flow, in well supplies, has a very definite effect on costs of pumping, for when a well is being used at high rates of draft, the draw-down is greater, and pumping costs step right up as the water level goes down. A check should be made at frequent intervals of the position of the water level in each well, and the information so gained should be used in working out pumping schedules, so as to minimize pumping lifts. This seems so elementary as hardly to be worth mentioning, and yet it is a point that is often overlooked; and some plants are entirely without means for measuring pumping levels in their wells. The simplest means, where it can be used, is a bob on a measured cord. More generally installed is the conventional brass tube, with its bottom end below the lowest position of the water surface, and equipped with a gauge and a bicycle pump at the top. When pumped up, the highest possible pressure indicates the depth of the end of the tube below the existing water surface.



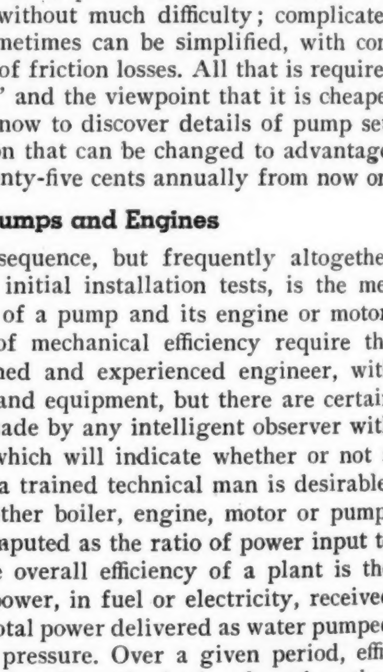
At left, an automatic priming system for centrifugal pumps (De Laval).

Pumping costs are affected by other factors than actual pumping heads. An examination of pump settings and connections may disclose, not water leaks but money leaks, some of which can be plugged. For example, priming, while not an expensive operation, does take time and power, and necessity for priming can sometimes be eliminated or reduced by changing pump settings, or by proper installation of check or foot valves. Improved priming devices may be worth a thought. The size and arrangement of pipes and fittings have a bearing on friction loss, and at least a rough check should be made to determine the existence of points of excessive loss. As an approximate estimate, the velocity of water at any point should not exceed about three feet per second, except possibly at the actual connection to the pumps. High points in piping layouts are excellent air traps, and air traps can greatly reduce the capacity of a pipe line, and thereby add another burden to pumping expense. A quarter-inch cock at each summit, to be opened for a blow-off at intervals, is an inexpensive plug to such a costly leak. Check valves sometimes develop leaks, tests for which can usually be made without much difficulty; complicated piping layouts sometimes can be simplified, with consequent reduction of friction losses. All that is required is the "seeing eye" and the viewpoint that it is cheaper to spend a dollar now to discover details of pump setting and connection that can be changed to advantage, than spending twenty-five cents annually from now on.

Pumps and Engines

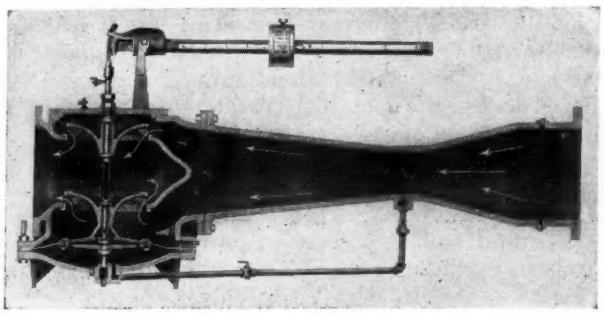
Of greater consequence, but frequently altogether ignored after the initial installation tests, is the mechanical efficiency of a pump and its engine or motor. Detailed studies of mechanical efficiency require the services of a trained and experienced engineer, with special apparatus and equipment, but there are certain tests that can be made by any intelligent observer with ordinary devices which will indicate whether or not a detailed study by a trained technical man is desirable. For any unit, whether boiler, engine, motor or pump, the efficiency is computed as the ratio of power input to power output. The overall efficiency of a plant is the ratio of the total power, in fuel or electricity, received at the plant to the total power delivered as water pumped against a definite pressure. Over a given period, efficiency can be computed on the basis of work rather than power, and this affords a means of estimating

The curves at the right show how the capacity of a pump is changed by the type of impeller used. When pumping conditions are changed, pumps should be checked.



efficiency from records ordinarily kept at a plant. First of all it is necessary to convert into terms of horsepower-hours all fuel or electrical energy used for pumping purposes during a given period and to divide by this figure the number of horsepower-hours represented by the total pumpage over the same period. If the resulting plant efficiency is satisfactory, no further study need be made, but usually it is desirable to make some analysis of different plant units to discover the location points of inefficiency that might be corrected.

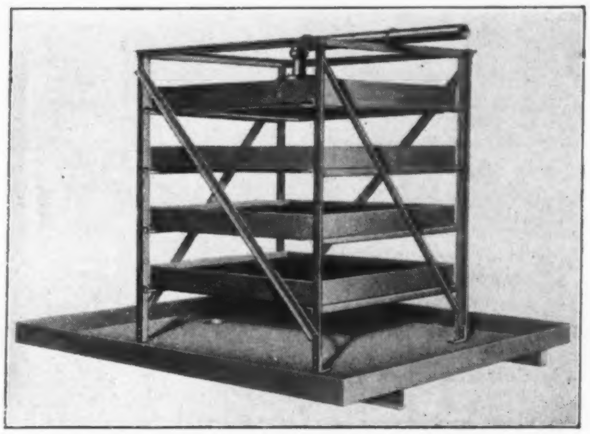
The efficiency of a steam boiler depends upon the total amount of energy furnished as fuel, and the total amount of energy produced as steam available for use. Observations should include blow-down and other similar periodic losses. An estimate of the weight of steam produced can be made by measuring the make-up water required to hold the exact original gauge level over the period of the test. The pressure (and if superheated, the temperature) of the steam should be considered in computing its energy content. Low boiler efficiencies are suggestive of poor firing technique, and this should be improved if necessary. Other common causes of inefficient boiler operation are dirty or scaly tubes, insufficient draft, leaky settings, poor fuel, improper feed water, and similar factors. Local conditions vary widely; common sense will usually suggest means



The Simplex standard filter rate of flow controller is based on the Venturi meter principle, which is best adapted for measuring plant intake.

of cutting fuel bills if there is room for much improvement in plant operation.

The individual efficiencies of pumps and of their motors or engines are difficult to establish with ordinary equipment, and it is usually sufficient to check the over-all rating of the complete pumping unit by measuring the power input and the pumping output for a given period of time. There are frequently periods when a single unit will serve the plant needs, and a careful check of power, or engine fuel pumpage and pressures, for even a short period will yield a fairly good estimate. So far as possible, operating conditions should correspond to *rated* pressures and flows for each pump. It sometimes happens that actual operating conditions are considerably different from the design characteristics of a particular unit, and one important point that should not be overlooked is a comparison of operating pressures and flows with the name plate ratings. Any considerable deviation from rated values may lead to serious operating inefficiencies, and may result in actual damage, particularly to electric motors. In line with such an investigation is a study of operating pressures at different periods. Centrifugal pumps particularly are designed to operate best at a fixed condition of head, an ideal that is quite difficult to maintain in most systems. There are instances where a study of operating records will indicate periods of steady and uniform pressures that can be utilized for improved



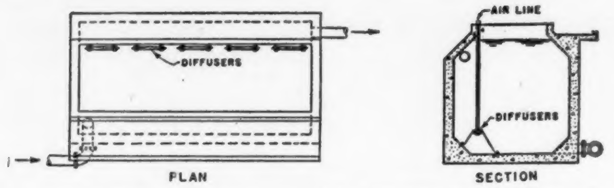
Simple coke tray aerator for the small plant.

operation. Where it is necessary to pump against widely varying conditions, an investigation of variable speed control may be valuable. The application of speel control will depend upon the particular installation, but with a centrifugal pump the only method of efficiently meeting variable conditions is by speed adjustment, and this proposition should be given thoughtful consideration.

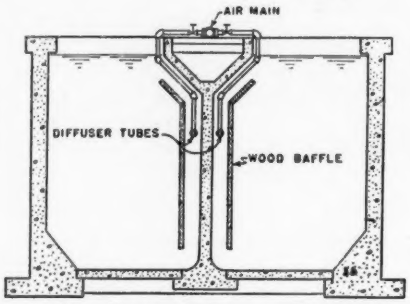
Measuring Devices

In all pump efficiency studies, reliance must be placed upon the accuracy of measuring devices. Chief among these is the meter or device for measuring water flows, and if the local conditions permit, the master plant meter should be checked for accuracy. The most desirable method is to pass a uniform flow through the meter for a given period and actually measure this quantity in a closed reservoir or tank. The measurement should be very carefully done, for most meters are fairly accurate and to be worthwhile, the check should be done with precision. Measurement of quantity can be made on either the suction or discharge side of a pump, and often a clear well can be used to advantage. The tank should be carefully measured at several different levels and volumes computed to within less than one per cent. The rate of flow during the test should be kept as uniform as possible, and a throttling valve used to compensate for fluctuations in pumping or other similar variations. It is frequently desirable to check the meter at several different rates of flow and establish a full rating curve. Lacking tank facilities, a less accurate check can be made by comparing the meter with some other type of measuring device. In all cases, the totalizing recorder as well as the rate indicator should be checked against measured flows.

An item of pumping equipment that must not be overlooked is the control apparatus. This is particularly true of electrically driven pumps, and improper starting and control of electric motors can result in considerable damage and hazard. Heavy motors as a rule should be provided with starting compensators, with overload and under voltage protection, and all motors should be equipped with circuit breakers or fuses and above all with safety switches. There are a multitude of cautions to be given, and rather than fill pages with warnings or ghastly examples of poor electrical layouts, the very earnest suggestion is made that a copy of the latest edition of the National Electric Safety Code be examined, and in the light of its provisions a conscientious survey of electrical conditions be carried out. Adequate protection to persons and machinery is not difficult or expensive to secure, and there is probably no other



PETERSBURG, INDIANA. WATER PURIFICATION—AERATION AND MIXING



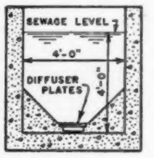


FIG. 3. TYPICAL DIFFUSER INSTALLATION IN CHANNEL

Cross-Section of Brownsville Unit Elevated Diffusers.

direction in which more can be done to eliminate foolish and costly expedients than in the electrical layout of many waterworks plants. Economy in such cases is to be found rather in safeguards against major damages than in daily operating savings.

Treatment Devices

A survey of plant conditions must of necessity extend to treatment devices, and should include consideration not only of operating costs, but also of treatment efficiencies. For example, an aerator unit is used either to oxygenate the water, to oxidize objectionable compounds, or to liberate harmful quantities of carbon dioxide and other gases. If the cost of securing the desired effect is too great, or if the full treatment is not obtained, means of correction should be considered. This requires making a brief analysis of operating costs for one type of aerator against another, and a study of operating results to evaluate the treatment.

More direct losses are apt to occur about tanks, basins and similar structures, owing to leakage. Although tests for leakage are comparatively easy to make, it is common to find, particularly with covered underground structures, that very large quantities of water are being lost. There have been several instances of the reverse condition, with badly polluted surface wash finding its way into clear wells and pure water storage basins. Extreme cases of leakage have been reported where structural foundations have been undermined, necessitating expensive repairs. In coagulation and settling tanks, where capacity and periods of detention have a bearing on the effectiveness of treatment, a check should be made seasonally to determine the flowing-through period under different conditions. A simple determination is the use of the dye or salt concentration method, which in capable hands will yield very accurate results. If it appears that under certain normal conditions the tank is being short-circuited, there is probably need for a change of baffles. It is not necessary to dwell upon the point that real effectiveness in settling basins relieves filters of a considerable load, and results in very definite operating economies.

Checking the Filter Units

Filtration is essentially a process, and more economies are to be realized by careful operation than by minor changes in a filter layout. It is important, however, to check the condition of each item of equipment to see that it is functioning properly, and in a sound condition. It sometimes happens that operators go about the business of handling filter plant equipment without knowing fully how each mechanism operates. For this reason, complete operating directions should be compiled and made available for immediate reference. Lack of familiarity with the details of operation may result in loss from service of valuable units. And, on the subject of records, there always should be a log of all inspections, replacements and repairs so summarized as to permit budgeting for plant repairs, and replacement of unduly expensive equipment.

An inspection, if it is to be anything more than routine, must uncover ordinarily unseen conditions. This means an examination of pipes, valves, rate controllers, gauges and similar portions of the plant hidden away in pipe galleries and unseen places. Usually corrosion conditions are at their worst in such spots, and annual painting should be the fixed policy, including a preliminary thorough cleaning and judicious application of paint, not indiscriminate covering of brass work, shafts, glands and every other exposed surface. The painter should be instructed, of course, and the detail to which this instruction must be carried is illustrated by the cherished picture of a workman carefully painting a silver manometer scale one day, and just as carefully, with reddened ears, cleaning it off the next. Rate controllers and gauges many times are neglected, to the consequent loss of efficiency in filter plant operation. A controller out of service may need nothing more than a new diaphram or pilot valve to restore it to active duty, and a little attention here may save the major operation of replacing a filter bed. All gauges should be taken out of service, emptied and cleaned at occasional intervals, and otherwise maintained in proper condition. Particular attention should be given to the wash-water controller, as it is a guard against excessive wash rates, and may serve to prevent the expensive removal, regrading and replacement of filter material.

It is advisable to make a study of the finished water to determine its corrosive qualities, or characteristics leading to possible deposits in water mains. The need for corrective measures should be determined and considered in adopting a treatment program. Unfortunately the need for and the benefits from such protective treatment are not immediately apparent, and for this reason the problem is neglected until the resulting condition has become serious; but a little foresight in this direction may eliminate higher pumping costs due to added friction, and expense for the cleaning of mains to maintain proper service.

The Softening Plant

One item of waterworks equipment that deserves regular care is the softening plant. A detailed and conscientious inspection may uncover conditions that lead to waste and inefficiency, although it is very hard to draw the line between faults in equipment and flaws in operation procedure. For example, in a zeolite softening plant, a careful record should be kept of operating conditions, including, for each regeneration, measurements of the sand under standard conditions, the volume of soft water produced, the total grains of hardness removed, and a calculation of the salt rate. Any decided variation in operating capacities indicates trouble, and calls for a careful check of conditions if undue expense for operation and maintenance are to be avoided.

Of major importance in water plant operation are first, the matter of operating records, so a check of the system should definitely include a critical review of such records, and second, the provision of adequate

laboratory facilities to maintain the necessary checks on operating routine.

Handling and Applying Chlorine

The use of chlorine in a water plant introduces another point for periodic inspection, and the maintenance of personal safety requires that such inspection be rigid. The fact that chlorine is shipped as a liquid, under pressure, is familiar to all waterworks operators. Since chlorine feed devices are constructed to deliver gaseous chlorine, it is necessary to evaporate the liquid, which is accomplished by a slight decrease in pressure. If the supply line is cooler than the cylinder from which the chlorine is drawn, the gas may reliquefy, causing spasmodic operation, hence it follows that the cylinder should be kept cooler than the temperature surrounding the control apparatus. Although chlorine itself is noncorrosive, the mixture of chlorine with water, or even with atmospheric moisture, is extremely corrosive, particularly to common metals, and any leak provides the setting for rapid disintegration of essential parts of the installation. To guard against such situations, it is only necessary to test every connection frequently for leaks. A bottle of ammonia should be instantly available around chlorine feed equipment for just this purpose. If possible, all apparatus containing chlorine should be isolated in a special room, and in any case a gas mask should be readily accessible. As with all mechanical equipment, the maker's instruction book and directions should be dug out of the musty archives and made conveniently accessible to the operators, if proper care of the equipment is desired.

The Distribution System

Unfortunately, the expense of operating and maintaining a waterworks system does not end with the discharge of water from the plant. In fact, in a great many instances that is the point where real worry begins, and in that intricate maze of pipes, tanks, valves, service lines and meters that constitutes the distribution system, there vanishes so great a proportion of profits that plant economies may seem petty in comparison. If that is the case, there is certainly a need for a careful investigation, and for the proper steps to correct the situation. Waterworks operation is not measured by economies alone, but by service also, whether it be to consumers, or for fire protection, and consideration must always be given to the improvement of service as well as to operating economy.

A starting point in the study of a distribution system is the measurement of pressures at various points and at various times. Considering always the effect of elevation, a great deal can be learned regarding the condition of pipes, the rate of draft, and other service factors from an examination of pressure data. To supplement this information, it may be advisable to conduct a few flow tests, using gauges and hose nozzles to determine the actual capacity of the system to feed water to critical points. Any serious discrepancy between the actual flow and that recommended as a minimum by the National Board of Fire Underwriters should lead to immediate corrective measures.

The same authority should be consulted for the minimum recommended elevated storage capacity, which must be correlated with pump discharge to provide a definite rate of fire flow for a definite period of time. If any material difference exists between actual and recommended storage capacities, advice should be sought as to the proper means of correction. Existing elevated tanks should be carefully examined, inside and out, for evidence of corrosion, and if necessary the surfaces should be carefully cleaned and repainted. All pipe connections should be inspected periodically for leaks and the tank valves tested for proper operation and adjustment. The riser pipe might be examined critically with the view of providing frost protection.

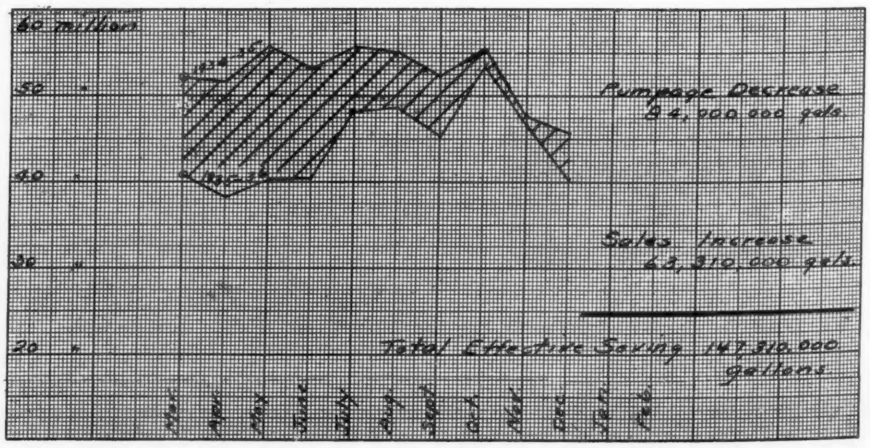
Maintaining Valve Efficiency

Valves are an urgent necessity for operating a distribution system. Although a particular valve may lie unused for years, a moment may arrive when the need for that valve is imperative, and a great deal of damage may be saved by insuring that each valve is ready for service. Many valves are completely lost, and others practically so, because no record of permanent reference marks is available. Several copies of such a record, preferably in the form of sketches, giving reference distances, together with information as to depth, size, and direction of opening should be available for any emergency. A complete check of every valve in the system should be made to determine its location, accessibility, and operating condition, and changes should be made if necessary on the basis of these findings. It is not uncommon to find valves closed when they are supposed to be open, and many main stoppages have been traced to this cause. A comparison of pressures in adjacent houses sometimes furnishes a clue as to the position of a valve.

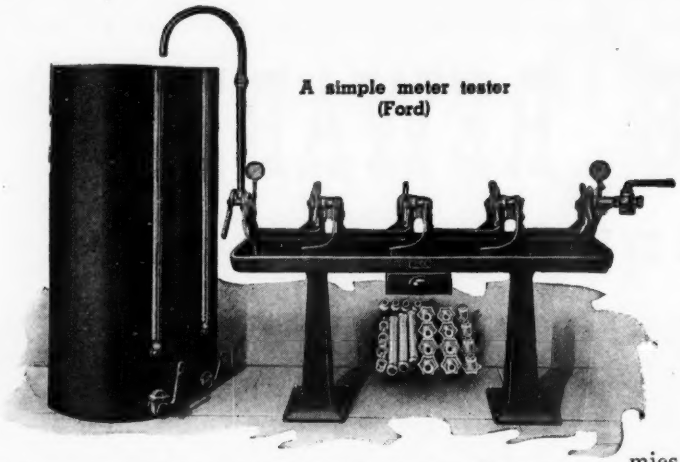
Obstructions may cause a great deal of trouble in water mains, particularly with regard to pressure and flow conditions. A brief study of pressures and flows will usually indicate whether or not serious obstruction exists. To definitely locate and evaluate water main stoppages, it is necessary to consult an experienced hydraulic engineer, but certain preliminary studies are of advantage in locating major trouble spots. An examination of cut pipes for incrustations and sedimentation may suggest precautions against further similar difficulties.

Leakage Losses and Surveys

A major loss to a waterworks is the leakage from mains of water that has been pumped, treated, and made ready for use. Leakage is so common that it is frequently accepted as being a necessary accompani-



This chart shows the reduction in pumping following a distribution system survey in Winchester, Va.



A simple meter tester (Ford)

ment to waterworks operation, but a never ending vigilance should be exercised to reduce the loss of water to an absolute minimum. A leakage survey should be developed according to a comprehensive plan, and all work arranged to fit into the program adopted. If possible, an accurate and detailed water waste survey should be made by competent operators, and very often such a survey pays real dividends.

Large leaks not only result in large losses, but may undermine pavements and building foundations, causing great damage, and their discovery should be the first object of search. To establish the location of such leaks, there are several methods that can be used, but one point to keep in mind at all times is that careful records of all data should be kept in convenient form. A simple and very accurate means of carrying out a leakage survey is to isolate definite small sections by closing valves, and to supply the section through a hose and meter connection between two hydrants. All water into the chosen district can be metered, and by noting the occurrence of excessive flows, and by successive reductions of district limits, a large leak can be rapidly located. The exact location can be determined by aquaphones or other equipment to detect the sound of running water, or occasionally by the flow in an adjacent sewer or other external evidence. The records compiled for the preliminary survey can be used to advantage in making a careful investigation of house service lines for leakage. Such a survey might consist of listening at each curb cock and hydrant between the hours of midnight and five a. m. to detect evidence of leakage. In sections where the total flow to the district is found to be small it is not economical to make a complete study of each service.

Another source of water loss is in the under-registration of meters, and in any complete system check-up, a review of meter testing methods should be made with the aim of reducing losses from this cause. It is recommended that a program be considered that will insure a test of each meter at intervals not to exceed five years. Such a course almost invariably leads to great savings, although many superintendents cannot be convinced of the fact without giving it a trial. The waste of water, or water unaccounted for, is often appalling and results in economic losses of major proportions. In a well constructed and maintained system, according to the A.W.W.A. manual, unaccounted-for water should not exceed ten per cent, and where the cost of treatment or pumping is high, every effort should be made to achieve a still lower figure.

Correcting Defects

No matter how carefully a waterworks system is managed, there is always an opportunity for betterment. In the case of a small boy, after his face and hands are washed, the need for a little excavation under his finger-nails becomes more apparent, and in the case of a waterworks there continually seems to be something next to be attended to. As soon as a defect of equipment or operation becomes obvious, the means of correction must be considered and put into effect. It frequently happens that a temporary expedient is used to remedy some particular trouble, when it is apparent that more comprehensive measures should be adopted, and consequently no permanent relief is secured. Under most conditions it is wise to secure the advice of a competent consulting engineer as to the scope of improvements to be considered and the relative economies to be gained.

Acknowledgments

Grateful acknowledgment for suggestions used in the preparation of this article and for real help in checking over possible trouble spots in a waterworks system is here made to the Deming Pump Company and through them to the Hydraulic Institute; to the International Filter Company and the Permutit Company; to Wallace and Tiernan, Inc.; to the Pittsburgh-Des Moines Steel Company; to the National Water Main Cleaning Company; and to many others who have contributed from their special experience with the hope of presenting some information of real benefit to the man responsible for waterworks operation.

Heat Losses and Insulation by Brick Walls

"The sum of the heat losses by transmission through the outside walls (1) and glass (2) as well as through any cold floor (3), ceiling (4), or roof (5), plus the heat equivalent of the cold air entering by infiltration (6), represents the total heat loss equivalent for any building." This is the definition of the American Society of Heating and Ventilating Engineers as given in their 1936 "Guide."

The New England Brick Co. states that they, as brick manufacturers, are directly interested only in the item marked (1), transmission losses through outside walls; but indirectly in all heat losses. Peculiarly, the one item into which brick and brick masonry enters is the least important of the many causes of loss of heat. In the average two-story single dwelling, the outside wall item accounts for only about 25% of the total heat loss equivalent.

At the Century of Progress Exposition in Chicago the Brick Manufacturers' Association of America exhibited a house built of brick masonry reinforced. Tests were conducted after the end of the Exposition, one of them being a fire test where the heat inside the house was raised to 1,625 degrees Fahrenheit. At a point on the outside of the wall directly opposite the point on the inside where this high temperature was recorded another thermo-couple recorded a temperature of only 80 degrees Fahrenheit. The eight-inch brick wall refused to allow any considerable amount of heat to pass through.

Brick walls, besides acting as protection against fire, are equally good factors of insulation. Real economy in insulation comes, however, from proper attention to the glass, the floors, roof, ceilings and the weatherstripping of doors and windows.

Largest Sewage Treatment Plant in the World Nears Completion

WHAT is known as the "Southwest Sewage Treatment Works" of Chicago, which is now nearing completion, is being built to operate more or less jointly with the West Side works (which went into partial operation in 1930 and was completed in 1935), being built contiguous thereto; and the joint works are now designated as the West-Southwest works. Some idea of the magnitude of the new works may be had from the estimated cost—about $8,250,000—and the fact that it is to treat the sewage of 1,490,000 population and industrial waste equal to another million.

Up to the present time no method has been found by the Sanitary District which is as well suited to the requirements of its problem as the activated sludge process, and this was adopted for the plant. Experience with it in other plants have led to several economies in size and cost. Several new features are embodied in the sludge disposal. The existing West Side Imhoff tanks will be used for settling sewage from that and two other areas and digesting the sludge therefrom, and possibly also will receive some sludge from the North Side area. The new plant will be operated at full load, taking the overload and fluctuations of the West Side plant; thus treating more sewage to a high degree than if operated separately.

The joint plant consists of a sewage pumping station combined with a blower plant and sludge-handling plant, preliminary settling tanks and two batteries of aeration and final settling tanks. The main sewage pumps and blowers for compressing air are to be driven by steam turbines, and turbine-driven generators will supply energy for smaller motor-driven equipment.

The sludge will be dewatered on vacuum filters and dried by the flash system, the dried sludge being blown into the furnace for fuel (supplemented by powdered coal if necessary); or it may be sold as fertilizer. Heat from the sludge incineration will be used to generate steam for the turbine-driven equipment. Final settling tank effluent will be used for condensing purposes.

The plans for sludge disposal have been based on experience at the Calumet works, where the plant for mechanical dewatering and burning has been tuned up so that continuous 24-hour operation has been maintained successfully for months and developed considerably more capacity than was expected. "The method adopted," says Chief Engineer Trinkaus, "has the advantages of continuous operation, less land requirements and smaller initial construction cost (than the plan originally considered for the Southwest works), thus effecting substantial savings. Further, the method offers the possibility of generating steam in combination with the incineration process to produce power."

The initial installation is for an average sewage flow of 400,000,000 gpd. and a maximum of 600,000,000 gpd.; and the plant is so arranged that it may be enlarged to an average capacity of 1,200,000,000 gpd.

During 1935 nine contracts were awarded; for the aeration and final settling tanks, to cost $3,110,000 (now practically completed); for furnishing blower and pumping units, to cost $629,600 (practically completed); furnishing sludge removal mechanism, to cost $200,600 (practically completed); furnishing venturi meters and valves and sluice gates, to cost $130,600 (practically completed); pump and blower house substructure, to cost $306,000 (fully completed); electrical equipment, in the aeration tanks, final settling tanks, operating galleries and pump and blower house substructures, to cost $66,000 (one-third completed); and structural steel for the pump and blower house superstructure.

The 1936 contract awards included two steam turbine-driven generating units, 5,000 kva. capacity, with appurtenances, to cost $200,000; condensing equipment for same, costing $54,500; feedwater heating equipment, $33,000; six power transformers, $27,000; superstructure of pump and blower house, $182,000 (completed); four steam generating units, each rated at 110,000 lbs. of steam per hour at 425 lbs. pressure, $428,000; main influent, effluent and sludge return conduits, service tunnel, control house, etc., $710,000; discharge chamber and main outfall, $290,000; sludge and scum removal mechanism for 12 preliminary settling tanks (6 to a tank, scraper conveyor type), $182,000; ten venturi meters, 12" to 114", $44,700; 24 gate valves and 40 sluice gates, $46,000; 55,000 air diffuser plates, $88,000; heaters for four drying units, $330,000; two electrical dust precipitators, $131,000; 24 vacuum filters and sludge conditioning equipment, $299,000; ash handling equipment at sludge disposal building, $70,000; electric lighting and distribution equipment about the plant, $51,000; and finally (on Nov. 5, 1936), installation of pumps, blowers, condensers, etc., furnished under other contracts and miscellaneous work, $590,000.

The steam generating units, furnished to burn either dried activated sludge or powdered coal, consist of water-tube boilers with superheaters, water-cooled furnaces, sludge burners, direct-firing pulverizing coal equipment, draft fans, etc. The vapors from the sludge drying process will be passed through the furnaces to destroy all odors.

The electrical dust precipitators are for removing 95% of the fine ash and dust from 180,000 cu. ft. of gas per minute before it discharges into the stack. There is ash-handling equipment for sluicing ash from the furnace bottoms and stack hoppers, and a dry ash handling system to remove the fly ash from the dust precipitators, boilers and air preheaters.

Each of the 24 vacuum filters has a drum 11.5 ft. diameter by 16 ft. long, capable of removing at least 900 gal. of water per hour from conditioned sludge.

The sludge removing mechanisms are for tanks 101 ft. wide by 103.5 ft. long, six parallel conveyors and a pair of cross conveyors in each tank. A scum removing mechanism for each tank consists of a skimming plate driven by an endless chain back and forth across the effluent end of the tank and discharging the skimmings into tipping buckets at either side of the tank.

Practical Kinks for the Engineer

Contributions to this page are invited. Send in your kinks. Public Works will pay $3 each for those published.

Sound Control in Blasting

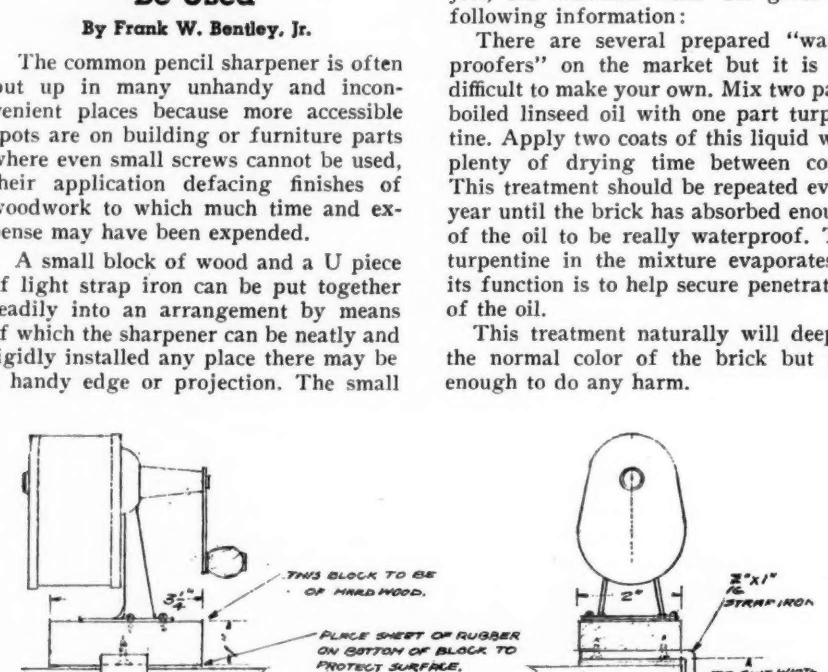
On a job in Ohio, which was near a sanitarium where noise had to be kept to a minimum, the sound of explosions from the necessary blasting was controlled as follows: While the holes were being loaded, a covering of rock-wool 3 inches deep was spread over the ground for a distance of about 6 feet around the hole. Over this was placed one to three layers of asbestos paper. About an inch of loose soil was shoveled on top of the paper to hold it firmly down. An average of 20 pounds of rock-wool and 25 square feet of paper was required for each hole (6 to 9 sticks in each hole). The total cost for rock-wool and paper was 47 cents. Over the rock-wool and paper were placed the usual mat to prevent flying stone. Instead of the usual noise, there was only a muffled blast, not jarring to the ear, and not disturbing to the patients. Later, this same procedure was used near dwellings with the same good results.

To Fasten Pencil Sharpener Where Screws Cannot Be Used

By Frank W. Bentley, Jr.

The common pencil sharpener is often put up in many unhandy and inconvenient places because more accessible spots are on building or furniture parts where even small screws cannot be used, their application defacing finishes of woodwork to which much time and expense may have been expended.

A small block of wood and a U piece of light strap iron can be put together readily into an arrangement by means of which the sharpener can be neatly and rigidly installed any place there may be a handy edge or projection. The small wedges, two in number, draw the lower part of the U piece and the block holding the sharpener securely to the projection strip without marring it in any way. The device is easily detached when desired to put it in some other location.



Fastening a Pencil Sharpener Without Screws

Numbered Tacks Handy on Measuring Sticks or Poles:

A long stick or strip is of course commonly made use of to measure the depth of fluid in tanks and other containers, the depth being the basis of a fairly close reckoning as to the amount the tank is holding at the time.

Such sticks or gauges are generally notched or nicked, numbers if possible to apply them being scratched or cut, which is hard to accomplish with any legibility.

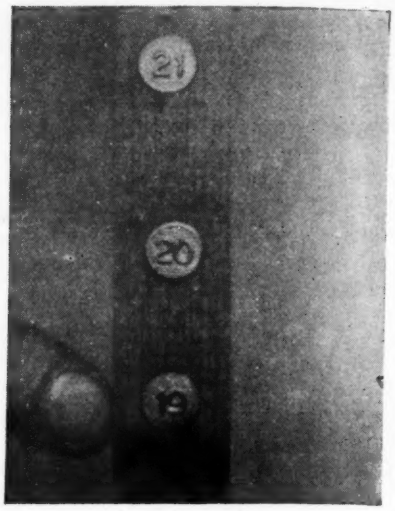
Common numbered door or window tacks can be neatly used on a quite small stick which is convenient. They afford a gauge or pole of this nature.

Waterproofing Brick

In response to a question on this subject, the National Lead Co. gives the following information:

There are several prepared "waterproofers" on the market but it is not difficult to make your own. Mix two parts boiled linseed oil with one part turpentine. Apply two coats of this liquid with plenty of drying time between coats. This treatment should be repeated every year until the brick has absorbed enough of the oil to be really waterproof. The turpentine in the mixture evaporates—its function is to help secure penetration of the oil.

This treatment naturally will deepen the normal color of the brick but not enough to do any harm.



You can use this in connection with the data on page 24

Heater for Chlorinator in Winter

By H. B. Carruth

During severe cold weather our chlorinator becomes so cold that it won't work without artificial heat. Under such conditions we have an electric radiant stove that throws heat directly on the chlorinator, and this keeps the chlorinator working properly all the time.

Water in Tractor Tires Increases Drawbar Pull

When using a rubber-tired tractor, an increase in drawbar pull is attained by filling the tires with water. The increase in pounds of pull is equal to about one-half of the weight added. In cold weather, of course, the water may freeze and ruin the tires through cutting the tube; expansion due to freezing is cared for by the expansion of the rubber. To prevent freezing, alcohol or calcium chloride admixtures are recommended because these do not injure the rubber. Goodyear recommends a 20% solution of alcohol or a 28% solution of calcium chloride, which will not freeze harder than slush at temperatures not lower than 20 degrees below zero.

Pocket Compass for Locating Iron Boxes and Manhole Covers

By H. B. Carruth

The needle of an ordinary pocket compass is considerably deflected from its northerly course when it is near an iron body. For this reason a small pocket compass may be pressed into service to locate meter boxes, valve boxes and manhole covers that are buried near the surface. It is advisable first to practice with the compass near an exposed iron cover and to note the deflection of the needle before trying to locate a hidden cover or box.

Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

The Water Wheel

Anthracite filters have been used for a number of months at each of four stations of the Philadelphia Suburban Water Co., which serves 316,000 people in 49 townships and boroughs, the other filters at each station being sand. The filters were operated at 50 to 75% of their nominal capacity; the turbidity of the applied water was uniformly 2 ppm, the color averaged 4 ppm at plant No. 1 and 7 ppm at No. 2. The size of medium, etc., for two of the plants were as follows:

Plant	*Material*	*Effective Size*	*Uniformity Coefficient*	*Average Length of Run*	*Wash Water, Pc.*
1	Coal	0.60-0.70	1.60	78 hrs.	0.96
1	Sand	0.40	1.47	56 "	1.32
2	Coal	0.70	1.60	87 "	0.67
2	Sand	0.38	1.20	44 "	1.16

No. 1 plant had been operating 8 mos.; No. 2, 5 mos.; sand and coal under identical conditions. Daily color and turbidity readings of the effluents showed no significant difference between sand and coal filters. The chlorine residual carried through the sand filters was greater than that through the coal. Bacteriological results were uniformly excellent, slightly better with the sand filters. As the table shows, coal filters used 27% less wash water at one station, 42% less at the other.[B5]

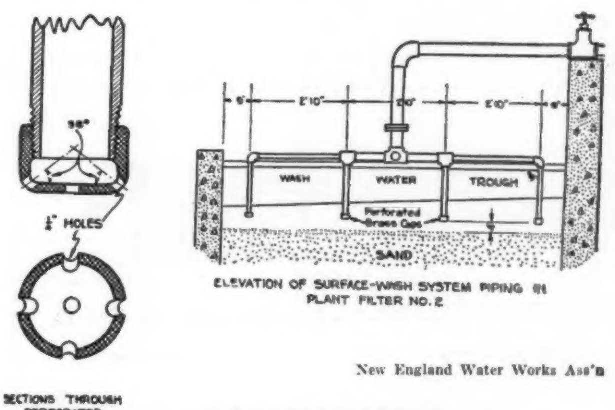
Filter bed troubles are mostly caused by failure of the washing system to remove from the filter all the material filtered from the water (assuming proper grading of filter materials and good distribution of wash water). No coating should be left around the sand grains; when it is, the bed may shrink and open cracks along the side walls and sometimes elsewhere, allowing some water to by-pass the finer surface sand and clogging to form along the walls. When mud balls form from accumulated deposits, these sink into the sand during washing; the higher the washing rate, the deeper they sink but the less the tendency to combine into masses. When washing is at a rate of 15 gpm per sq. ft. mud balls may, in a few months, form to the amount of 3 to 5% of the top 6" of sand, but less where a higher rate of washing is employed, and when more coagulated matter is settled out before filtering.

Jet action at the sand-gravel junction causes ridging of the gravel, even permitting sand to work down into it. Gradual transition of size at the sand-gravel junction is advised.

Washing at a high rate keeps them in better condition than at a low one, but neither this nor periodic restoration is a satisfactory solution. "The use of jets of water from a piping grid located above the sand and known as the surface washing system offers the only known practical means of keeping the sand beds as clean as they should be kept. This is used in addition to back washing and at the same time." From 2 to 8 gpm per sq. ft. of water is used for surface washing, depending on the tendency to clog; few will require more than 3 to 4 gpm when the pressure head at the jets is 20 to 50 ft. One-quarter-inch holes should be used for pressure heads less than 50 ft., smaller sizes for higher pressures. The holes should be in brass pipe rather than iron. Maintaining filters in excellent condition by use of the surface washing system is not costly.[B4]

Chlorine plant installations should be located far enough from the first service to allow at least 10 min. contact period before reaching the service, or 30 min. if ammonia is used. The building housing it should be sufficiently large to permit repairs conveniently; brick lined with hollow tile, concrete lined with pressed board with an air space between, or a wooden structure lined with insulating material. Tubing carrying the chlorine to the main may be run in a tile conduit to advantage in replacing, repairing, etc. Desirable to set platform scales down in floor to eliminate lifting cylinders; also to raise floor above the ground the height of a truck body. Building should be heated to 70° to 80° for solution feed equipment, 50° to 55° for dry feed, above freezing for hypochlorite; for this, oil burners satisfactory, small hot-water boiler with radiators more so, electric heating sometimes used, having advantage of excellent control.[B6]

Katadyn treatment of swimming pool water was experimented with in Brooklyn, N. Y., by Dept. of Water Supply, Gas and Electricity. Dosages of 30 gamma or over in city water reduced the B. Coli to 0 after 40 min. contact. But the presence of ammonia seemed to reduce or entirely eliminate such action, and ammonia accumulates in pool water due to contamination by swimmers. Also the silver causes turbidity, and pool water should be crystal clear; 37° C. bacteria are not affected and these may include germs affecting eye, ear, nose and throat; the action is too slow (40 to 120 min.); the cost for silver is much greater than for chlorine; and it may cause argyrosis—a permanent darkening of the skin, for which no cure is known.[B13]



SECTIONS THROUGH PERFORATED BRASS CAP.

New England Water Works Ass'n

Details of surface-wash piping

Earthquake resistance of elevated water tanks was studied by use of models and conclusions reached that the standard type of tank tower in common use is poorly adapted for withstanding severe earthquakes, because of absence of both damping action and ability to withstand large deflections. This cannot be bettered materially by a moderate degree of strengthening. Suggested rules for safe design for 50,000 to 100,000 gal. tanks on 150 ft. to 100 ft. towers include: Design structural frame for a static horizontal load of 0.1 weight of tank and water applied at center of gravity of tank. Provide springs such that, with initial compression set for a horizontal force at the tank equal to 0.2 weight of tank and water, the tower can deflect at least 15″ parallel to its sides before the springs close; the individual springs being so designed that the total tower deflection is about equally distributed between the panels. There should be damping forces such that the energy dissipated by damping during motion of tank to maximum safe deflection and back is approximately 50% of the energy stored elastically when the structure is at its maximum safe deflection. The damping may be produced by simple sliding friction if desired.[K6]

Unstable support for mains is found in a short stretch of Manhattan Ave., New York, where a very deep gully was filled with rock and earth fifty years ago but continues to settle under vibration of elevated and surface cars, causing occasional breaks in the five lines of 48″ mains laid on it. To prevent this, there has just been completed a mattress of concrete 18″ thick with cross and longitudinal reinforcement at top and bottom, placed under the pipes, having an area of 34.5 ft. by 145 ft., on which each main is supported on a concrete cradle. It is estimated that this can support a dead and live load of 2,000 lb. per sq. ft. over an area 14x14 ft. under which settlement had occurred. Also it will prevent surface water reaching the fill and so make settlement less probable, and minimize effect on pipe of vibration of surface traffic.[F50]

Jute packing, used in making lead joints in b & s pipe, was found by the Mass. Dept. of Public Health to contain bacteria of the coli-aerogenes group in numbers ranging from 10 to 1,000 per gram of jute, whether loosely twisted or hard braided, but untarred. Of 4 samples of tarred jute, 3 showed no coli-aerogenes and few other bacteria. (Tarred jute would probably produce taste with chlorinated water.) The jute contains favorable food material for bacteria, and if sterilized jute be placed in water, the bacteria in the latter will increase rapidly in number. It was concluded therefore that jute is not a satisfactory packing for joints in water mains.[B8]

Chlorinating new mains in Connecticut is practiced with a recommended dosage of at least 3 ppm and several hours contact period, applying to water by chlorine machine; or by placing in the pipe, when laying it, HTH, "Perchloron" or other chlorine compound of high concentration.[B6]

Goose necks or other flexible connections between services and mains are not used in Taunton, Mass., because they involve 4 joints instead of one, each a possible source of leaks; lead goosenecks may crystallize and split; the contact of different materials at each joint favors galvanic action; the bend may cause deposits and prevents clearing a clogged corporation by use of wire or rods. If the main is tapped on the side and a rigid connection be made between corporation and a straight service pipe, a straight, uniform waterway is given, friction loss reduced, and clearing facili-

tated. But both main and service must have permanent solid support. Of 500 services so connected during 9 years only one has failed, and that because of poor workmanship.[B12]

Gravel-packed wells may be constructed in five different ways: 1—Outside casing drilled through aquifer, smaller casing with screen set inside this, and annular space filled with gravel. 2—Outside casing to top of aquifer, inside casing with screen carried through aquifer, gravel placed between casings and lowering as sand is pumped in through screen. 3—"Mud scow" method—two girders (for anchors for hydraulic jacks) are placed in hand-dug pit which is refilled; hand excavation in a large "conductor pipe" carried as deep as possible, then well casing set and pushed down by jacks while a very heavy bailer, churned up and down, removes the soil inside it. 4—Modification of 3 in which a syrupy liquid of mud and water is pumped through a longitudinal hole in the tools and flows up the outside, bringing the cuttings up in suspension ("mud-walling"). 5—Caisson method—excavating hole 40" or more diameter entirely through aquifer, sealing bottom with concrete plug, placing inner casing with screen, placing gravel and removing outer casing.

The packing gravel should be as nearly spherical as possible, diameter about 6 times that of the sand and uniform in size, of hard, durable material.[A84]

Geophysical exploration of subsurface conditions, magnetic, gravitational, electrical and seismic, especially the two latter, are useful in determining foundation conditions for dams, presence of underground water and other conditions important to the waterworks engineer. Explosives are used in the seismic methods; the electric ones depend on the different conductivities of the various materials of the earth's crust. Depths to underground water have been determined with an error of less than 6%, and indications of the existence of such water were correct in 94% of the locations tested.[L10]

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c, Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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7. Chlorination of a Cambridge Main. By F. E. Smith, pp. 57-59.
8. Experiences With Chlorinating New Mains. By G. O. Adams and F. H. Kingsbury, pp. 60-68.
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7. Decatur's City Water Works a Show Place. By W. H. Herring, pp. 63-64.

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6. *t*. Earthquake Resistance of Elevated Water Tanks. By A. C. Ruge, pp. 801-850.

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10. *p*. Frazil Ice Problems in Pumping Stations. By R. Dorion, pp. 11-14.
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"Materials" Covered by Bond May Include Equipment

A statutory contractor's bond may contain obligations broader than those required by the statute. This rule is supported by the great weight of authority. A contract for the work and materials on a state highway construction project contained the provision that in addition to materials incorporated in the project "materials" included "equipment and other materials used" in the performance of the work. In an action on the bond for some 22 claimants for equipment or supplies not consumed in the performance of the contract, the Washington Supreme Court said, Western Steel Casting Co. vs Edland, 61 P. (2d.) 155, that had the bond been a strictly statutory bond no recovery could have been had on these claims, the Washington cases confining the term supplies and provisions as contained in the statute to such as become a part of the completed work or such as are consumed in the performance of the work. The contract provision broadening the definition of materials was obviously put in to secure materialmen who furnished equipment and supplies not consumed in the work.

In this contract the only thing the contractor furnished that went into the completed work, the highway, was crushed rock. He had to keep a rock crusher operating, maintain bunkers, and keep trucks moving. Replacements of machinery and equipment would be required, which might or might not be consumed in the work. The court held the parties had a perfect right to broaden the scope of the term "materials" by contract; and sustained the claims so far as they were proved.

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Test Section Results of Cement-Bound Macadam

EXPERIMENTAL cement-bound macadam surfacings of the top-grouted type were constructed in 1935 on a stretch of the Padua-Conselve Road (Italy), in order to investigate (a) the influence of cement content on the strength and durability of the surfacings; (b) the possibility of employing river gravel as coarse aggregate together with sand from the same source; (c) methods of preventing excessive marginal stresses in the neighborhood of a street railway; (d) methods of joint construction and the optimum spacing of joints.

The experimental length was about 630 feet.; the daily traffic load included about 1,000 tons of rubber-tired vehicles and 900 tons of animal-drawn vehicles having iron tires; the latter average is considerably exceeded in certain seasons. A street railway ran beside the roadway at street level. The width of the roadway varied from 16 ft. 6 in. to 20 ft. The length was divided into six sections, in each of which the mortar had a different cement content.

In order to prevent the foundation soil from becoming mixed with the mortar the foundation was thoroughly cleansed with water, covered with coarse sand and rolled with a 17-ton roller. Half the roadway was constructed at a time. The longitudinal joint was formed by squared timbers $3\frac{1}{2}$ in. by 7 in. embedded in the foundation to a depth of 1 to 2 cm. (0.4 to 0.8 in.); immediately before the material was placed the inner side of the timber was dressed with a thick grout and coarse broken stone was laid against the wood by hand in order to prevent the escape of mortar under the joint. A ditch about 10 in. deep was dug between the rails and the margin of the roadway. A layer of mortar covered the bottom of the ditch which was filled with broken stone.

Transverse joints were formed at short intervals in the earlier sections. The best results were obtained by the use of squared timbers $3\frac{1}{4}$ in. by $3\frac{1}{4}$ in., the joints being finished by hand. Steel strip 0.4 in. thick proved unsatisfactory, as the final rolling usually resulted in displacement and distortion of the steel, and in the few cases in which this did not occur the steel could not subsequently be withdrawn from the surfacing.

The aggregate consisted of river gravel; it contained about 55 per cent. of hard limestone, together with granite, schist, quartz and flint. A considerable proportion of the stone was rounded. In order to facilitate grading, the aggregate was spread in two courses, the second being placed during the preliminary rolling of the first; the material was sprayed during rolling and was thoroughly washed before the grout was applied. It was found, especially in the case of the leaner mixes, that a wet grout was necessary to ensure proper penetration; the coarser particles tended to separate from the mix and remain on the surface, possibly because the grout was applied and spread with spades.

It was found advantageous to place the mortar in

two applications; in the first, about a third of the total quantity of mortar with water content of about 16 per cent. was quickly poured from buckets, and rolling was begun at once; the remainder of the mortar, containing about 9 per cent. of water, was then spread by means of spades, broomed in, lightly sprayed and rolled. Water sprayed on the rollers themselves did not become evenly distributed, but tended to run down in channels and produce furrows on the road surface. A 10-ton tandem roller was used.

The number of traverses noticeably influenced both the degree of compaction obtained and the adhesion between cement and stone. Samples taken from the section containing the highest proportion of cement after 60 traverses appeared strong, but the aggregate was easily detached. After 100 traverses the adhesion was improved, but was still poor in the case of quartz or flint aggregate. After 180 traverses (as demanded by the existing specification of the Ministry of Public Works) adhesion and penetration were alike satisfactory.

Three types of surface finish were used: (a) grout was broomed into the aggregate, leaving the latter exposed; (b) a thin layer of mortar (½ to 1 cm. thick) was spread on the surface and smoothed with a levelling board; (c) mortar was spread and smoothed as in (b), but the surface was lightly broomed in order to render it non-skid. Method (b) proved the most satisfactory; where method (a) was employed loss of aggregate under traffic could be obviated only by the allowance of an excessively long curing period, while surfaces finished by method (c) were liable to rapid wear and quickly became dusty. The finished surface was covered with wet sand 12 hours after completion. Traffic was excluded for 7 to 10 days, and light traffic only was admitted when the road was first opened.

From compressive strength tests at 7 and 28 days, the optimum mix was found to be 1,261 lb. of cement per cu. yd. of sand. This content also corresponded with the maximum density of a mix of the required consistence. The resistance to abrasion measured on the Amsler machine was almost the same in all cases except that of the leanest mix. After nine months' exposure to traffic the 1,261 lb. mix showed the least wear. There was slight hollowing round the waterworn stones, but not round the angular fragments of aggregate, although adhesion in the interior was uniformly good whatever the shape of the aggregate. Cracking did not develop even in the more recently-constructed sections, in which transverse joints were not provided. Transverse sections of the surfacing showed the condition of the foundation to be of the first importance, a wet foundation resulting in the loss of a considerable proportion of the cement and hence in a much thinner surfacing.

The author draws the following general conclusions from the experiment: (1) Uniformity of wear results from the use of coarse and fine aggregate of similar composition in top-grouted macadam. (2) The coarse aggregate should be placed and rolled in two layers; the wearing quality of the surface is improved if the upper course consists of broken stone, while gravel may safely be used in the lower course. (3) The proportion of cement in the grout should be such as to give the maximum density at normal consistence. (4) The grout should be spread in two applications, the former containing about 16 per cent. of water and the second about 9 per cent.; an 8 to 10-ton roller should be used during the second application. (5)The final rolling should be continued as long as possible, 180 to

200 traverses being desirable. Penetration of the grout should be assisted during the rolling process by brooming and light spraying with water, the quantity of which should not exceed 5 per cent. of the weight of the grout employed. (6) In cases where a protective surface treatment is to be applied the optimum cement content noted above should be reduced by 20 per cent.; a few months should elapse before such treatment is given. By A. Pagello, in *Strade,* reported in *Road Abstracts.*

Acceptance of Work Relieves Contractor of Liability for Injuries

The acceptance of the work by the supervising engineer and the opening of a highway to traffic will relieve a road contractor of liability for injuries to third persons after the acceptance. A formal acceptance is not necessary. A construction company which had been relieved by the resident engineer from maintaining barriers and lights before the acceptance and approval of the work by the director of highways was held not liable for damages sustained in an automobile collision caused by the absence of barriers, although the road was not open to traffic because a bridge contract was not completed. Donaldson v. Jones, Washington Supreme Court, 61 P. (2 d.) 1007.

Recovery for Extras Due to Indefinite Specifications

The specifications for a contract to lay a bituminous macadam highway provided: "Top Dressing. If required, a top course of clean sand or grit . . . shall be uniformly spread on the finished pavement" at a prescribed amount per square yard. The engineer in charge directed the contractor to apply the sand. The latter under protest did so. On making his bid he had not estimated on furnishing and applying the sand.

The New York Court of Claims, Schroeder v. State, 293, N.Y.S. 814, held that the contractor was entitled to recover the reasonable value of the additional cost to him, although he had supplied sand upon another contract for such a highway, and although he admitted his failure to bid for supplying sand was in part due to his own carelessness in reading the specifications. A bidder, the court said, could not tell from these how much, if any, sand would be required, or if "required" meant by the engineer, the conditions of construction or the result obtained in laying the macadam.

Annual Road Revenue Averages $460 Per Mile in United States

In the early days of the United States toll roads were a source of much annoyance in many sections and frequently there were organized protests against toll rates that were considered excessive. But the revenue from those early roads was but a pittance compared with the enormous revenue now collected from highway users by the federal and state governments, according to the American Petroleum Industries Committee.

Last year an average of $460 per mile was collected on the 3,000,000 miles of highway in the United States. Total taxes paid by motorists reached the staggering total of $1,400,000,000, or one-seventh of the total taxes collected from all sources by the federal, state and local governments. Of that amount about two-thirds, or $880,000,000, represents revenue from gasoline taxes.

Patching Bituminous and Water Bound Macadam

Under modern traffic conditions, the use of a bituminous binder is necessary in patching water-bound macadam surfacings. Shallow depressions are filled with stone chippings which are tamped and subsequently dressed with bitumen emulsion; the surface is covered with fine chippings (¼ in. down) and again tamped. Holes of considerable depth are cleared and partially filled with broken stone; this is tamped, treated with emulsion and covered with coarse chippings. These are tamped and dressed with emulsion, which should also be spread on the road surface round the margins of the patch; the whole of the area so treated is finally covered with fine chippings.

The repair of bituminous surfacings is effected by similar methods, but more care is necessary in leveling and sealing. The author criticises the practice of finishing the patches to a slightly higher level than that of the road surface, on the assumption that consolidation under traffic will equalise the levels. He considers that the patch should be finished either flush with the road surface or at a slightly lower level, as subsequent filling can easily be effected, if necessary. The chippings employed are often too coarse, and produce an open surface texture which retains moisture and dirt, and facilitates the loss of aggregate. When coated chippings are used, the surface should first be painted with emulsion, in order to ensure adhesion. Treatment with fine chippings and emulsion permits the repair of shallow depressions before the road surface becomes too uneven.

The use of emulsion is also recommended in minor repairs to stone block paving; holes left by the displacement of individual blocks can be filled either with coarse bitumen-coated chippings which are tamped and covered with fine material, or with plain chippings which are tamped, grouted or sprayed with emulsion, and covered as before. Depressions due to subsidence are treated by cleaning the surface, especially the joints, with wire brushes, filling up the joints with emulsion, covering the surface with chippings of suitable size, tamping and dressing with emulsion. If the depressions are deep, several thin layers of chippings must be placed, tamped and covered with emulsion, with a final dressing of fine material. If bitumen-coated chippings are used, a dressing of emulsion should first be applied to the road surface. The use of coated chippings is also recommended for patching the light surfaces of footways and for levelling sett-paved approaches from the carriageway to gardens, etc.

This is from an article by E. Schneider, in *Bitumen*, which was reported in *Highway Abstracts*.

Bidding on Patented Articles or Processes

The Texas Commission of Appeals holds, Vilbig Bros. v. City of Dallas & Uvalde Construction Co., 91 S. W. (2d.) 336, that two forms of competitive bidding may exist. One is secured by calling for bids on only one kind of material for the work, which is a competition among bidders on the same thing. The other is secured by calling for bids on several kinds of material, any one of which is suitable for the work. This form brings bidders on different things in competition with each other. The latter kind of competition includes the former.

The court agrees with the majority rule that if all the competition possible in the circumstances is permitted, a patented article or process may be specified.

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

The Digestion Tank

New York City's sewage treatment projects number 38, of which the Coney Island plant (35 mgd.) has been built, the Wards Island plant (426 mgd.) is under construction, and the first contract has been let on the Tallman's Island works (70 mgd.). The 13 older plants —8 fine screening, 1 septic tank, 1 sedimentation and 3 coarse screening—treating 120 mgd., most of which will be abandoned or substantially altered. To clean up Flushing Bay for the World's Fair, in addition to the Tallman's Island works, the North Beach screening plant is being reconstructed and several intercepting sewers built. Plans also are under way for a 65 mgd. activated sludge plant on Jamaica Bay. The ultimate sewage program is expected to cost about $200,000,000. To bring Manhattan sewage under the Harlem river to the Wards Island plant, a tunnel is driven under the river at a depth of 300 ft., which probably will be increased to 500 ft. for the middle 700 ft. because of a bad fault in the rock. The new Coney Island plant replaces three old ones built 50 years ago, and its cost of operation is about $100,000 as compared to $150,000 for the old plants.[C32]

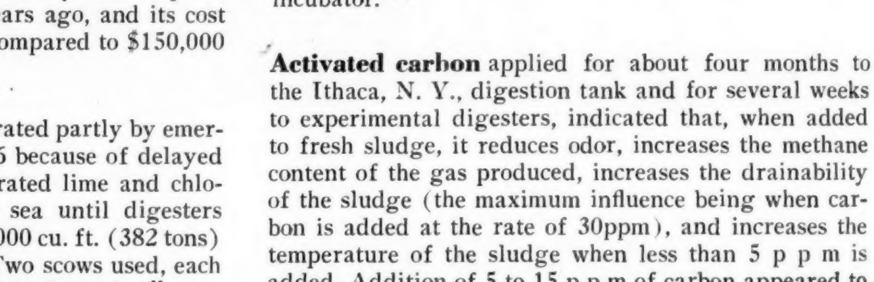
The Coney Island plant was operated partly by emergency equipment in 1935 and 1936 because of delayed contract work, using ferrisul, hydrated lime and chlorine. Raw sludge was barged to sea until digesters were ready in June, 1936, about 12,000 cu. ft. (382 tons) at a load at 8 to 10 day intervals. Two scows used, each divided into 6 tight bins with outlets through 6" gate valves in side of scow; flushed with sea water after emptying. Contract price for towing, $210 per round trip. One digester started with lime in April, 1936, others seeded from this without lime between then and August, kept at 83° F., no difficulties. Supernatant flowed onto adjoining sandy areas or pumped to raw sewage; digested sludge also pumped to sandy areas, when dewatered there is broken up and turned under to make top soil—desirable to prevent sand drifting. A scow load 88.3% moisture, 36 tons of dry solids, was carried to a new park and used there as fertilizer, at a cost of $2.80 per dry ton. Plan is to use dewatered sludge cake as fertilizer on city parks. Digester gas is used in three 300 hp. engines, energy generated used to pump all sewage and operate plant equipment; Btu value, 650 per cu. ft. In December, 1936, digesters furnished 2,522,720 cu. ft. of gas, 109,760 kwh. generated.[C33]

Activated sludge design at Chicago developed since 1923 from channel width of 16.12 ft. to 33 ft. (experiments are under way with 67.5 ft.) giving same quality of effluent and same volume of air per gallon. Diffuser plate ratio has been increased from 1:9.4 to 1:20.2. Aeration period has been decreased from 6.25 hrs. to 5.0 hrs., and 3.0 to 3.5 hrs. has been proved practicable. Amount of air has been reduced from 1.25 cu. ft. per gallon of sewage to 0.8 and consistently good results have been obtained with 0.4 cu. ft. Agitation of effluent gives substantial increase in dissolved oxygen, obtained by drops in channel.[C34]

Gadget contests are being held by a number of sewage works associations. Some give cash prizes, some certificates of honorable mention. The New York State Sewage Works Association last fall gave first award for a sludge grinder and shredder for processing dried sludge for use as fertilizer; second award for a laboratory device for centrifuging sludge samples; third, for device to bleed and overcome the air binding of a centrifugal pump. The Central States Association gave first prize for an automatic sampler; second for a portable turbidimeter, and third for a cheap spacious 20° C incubator.[C26]

Activated carbon applied for about four months to the Ithaca, N. Y., digestion tank and for several weeks to experimental digesters, indicated that, when added to fresh sludge, it reduces odor, increases the methane content of the gas produced, increases the drainability of the sludge (the maximum influence being when carbon is added at the rate of 30ppm), and increases the temperature of the sludge when less than 5 p p m is added. Addition of 5 to 15 p p m of carbon appeared to increase the gas yield at 20° C but not at 28°, but to reduce it when added in greater amounts. Addition at 20° C. hastened completed digestion, but not at 28° and 45°.[C30]

A **storm water overflow** which is recommended by an English authority is shown in the accompanying drawing. The dry-weather sewage flows in a channel through the center of an overflow chamber, and excess water flows over two sills, one on each side, while scum plates prevent floating solids from overflowing. The overflow water leaves the chamber through a storm sewer at a slightly lower level. It is recommended all storm overflows be inspected after each storm to see that they are free from debris. (Most English sewers



English type of storm water overflow

are combined, storm water overflowing to a near-by stream when it exceeds 3 to 6 times the dry-weather flow, where there are such streams.)[D32] But J. Hurley told the Institution of Sanitary Engineers that such overflow sewage caused far more pollution than the effluent from storm-water tanks at the treatment works; for the overflow often comes into operation too soon and stays in action too long, owing to bad design, suspended matter has not previously been removed, and discharges from sewer overflows often reach the stream before its volume has been materially increased by the rainfall on its shed.[D34]

Sludge disposal of 487 tons of dry solids per day at Chicago Southwest works by mechanical dewatering, heat drying and incineration found cheaper and less odorous than digestion in tanks and drying on sand beds. Flash drying in 1.5 min. better than 90 min. in rotary dryer. Vacuum filters reduce moisture from 97-98% to 75-80%, after conditioning with ferric chloride at rate of .5% of dry sewage solids. This is mixed with dried sludge to give 50% moisture, then flash dried with vapor superheated to 1,000° F., giving sludge with 10% moisture which is burned in a furnace, supplemented with powdered coal when necessary. All products of combustion are passed through a dust precipitator. The furnace is used to generate steam, which is used in steam turbines which drive the main sewage pumps, blowers for aeration, and electrical generators, plant effluent being used for condensing water. Many of these features would not be practicable for smaller plants.[C34]

Sewer enlarging is being done in London by cutting away the bottom part of a 5 ft. brick sewer, digging out the clay soil below so as to lower the invert and so change it to an elliptical sewer. At another place a relief sewer is run parallel to a too-small combined sewer to remove storm water (exceeding 6 times dry-weather flow) and, to provide an overflow from the latter to the former while the sewer is in use, the relief sewer was built in contact with the old one and an opening cut in its wall to form two 10 ft. overflow weirs with a column between; the sewage meantime being carried by a lining of cast iron segments which had been lowered through a manhole into the sewer and bolted together to form a tube, oakum being calked between the ends of this and the old sewer.[D35]

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c, Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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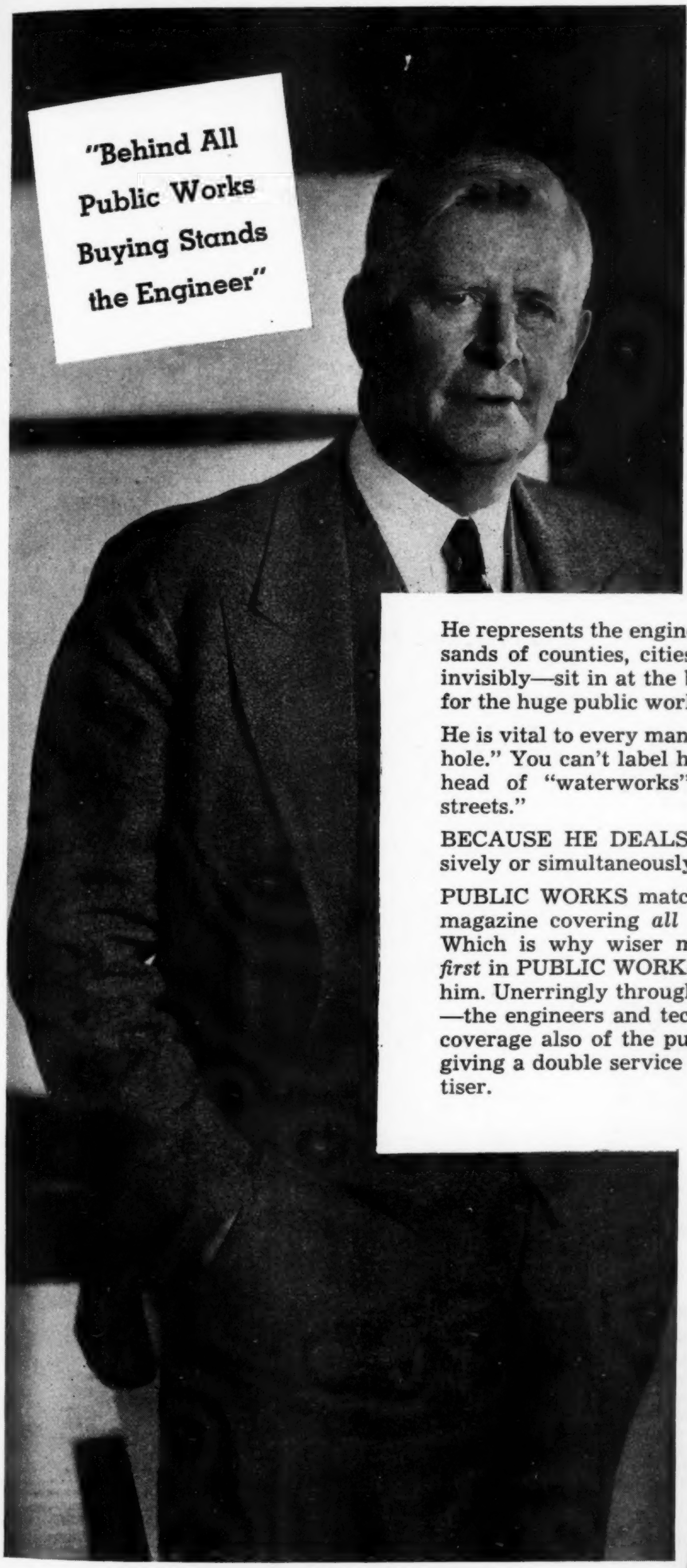

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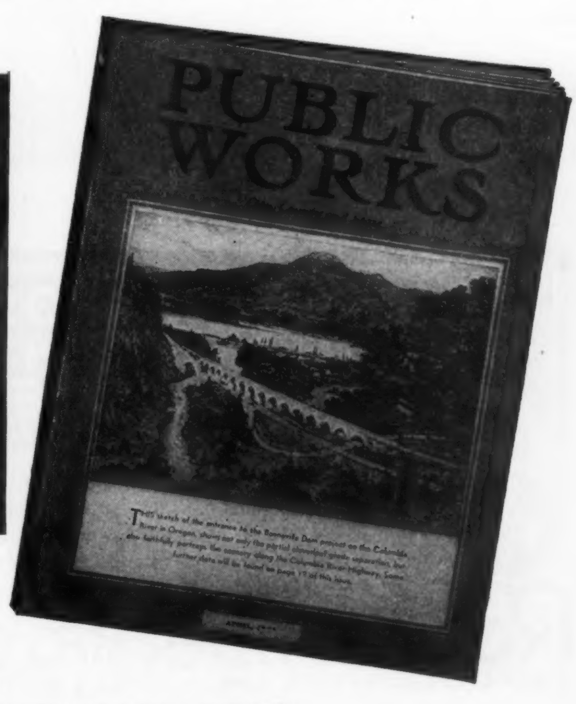

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52. Grit and Screen Chamber Studies Aid Minneapolis-St. Paul Works. By G. J. Schroepfer and K. L. Mick, pp. 268-272.
53. Mechanization of Sewage Plants Advancing in New York State, p. 272.
54. Flood Sanitation Problems. By H. K. Gidley, pp. 273-274.
55. Sewer Rental Finances Operation at Bowling Green. By A. H. Smith and A. H. Niles, pp. 275-276.
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Forfeiture of Bidder's Deposit for Failure to Sign Contract

An advertisement for bids for the construction of sewage treatment works, a PWA project, provided that no bidder might withdraw his bid for 30 days after the date set for opening the bids. The day after the opening of the bids the lowest bidder wrote the sewer commissioners attempting to withdraw his bid. The commissioners awarded the contract to the next lowest bidder, but this was disapproved by the Federal Emergency Administration of Public Works. The lowest bidder was then notified that the contract had been awarded to him and that in case of his failure to execute the contract and bond within ten days his $5,000 deposit would be retained by the town as liquidated damages, in accordance with the terms of his proposal. He did not execute these documents within the ten-day period, but sued the town for return of his deposit. The Massachusetts Supreme Court held, Daddario v. Town of Milford, 5 N. E. (2d.) 23, that the plaintiff, not having withdrawn his bid at the end of the 30-day period, could not recover the deposit. The award of the contract to him was made five days after the expiration of that period. The court said that the contract was clear that the plaintiff and the town understood that the certified check delivered to the town was to be forfeited as liquidated damages if the plaintiff within 30 days after the opening of the bids withdrew his offer. It held plaintiff could not complain that the sewer commissioners tried to allow him to withdraw his proposal.

Fort Morgan Has 6-Year Plan

A six-year program of public works for the city of Fort Morgan, Colo., amounting to $1,753,000, was sent to the state planning commission recently. The program includes: expenditures on the electric power plant, transmission line and street lighting extension; rebuilding and extension of the present domestic water system; curb and gutter work throughout the city; improvements on the cemetery, a zoning ordinance; equipment and improvements of parks and recreation grounds; and the purchase of fire equipment. *Colorado Municipalities*.

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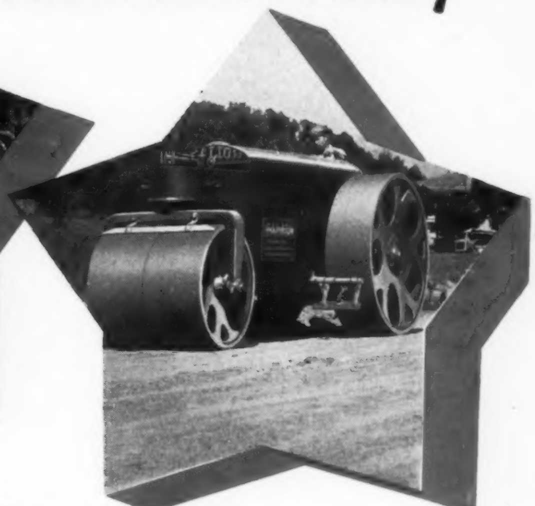

The "Warrior" weighs from 5 to 10 tons. Has six cylinder engine. Scarifier extra.

The Trench Roller does a splendid job on repair, widening, relocation, elevating curves on some types of new construction work. 4-cylinder engine — either 10 or 20 inch face rolls can be supplied.

This Portable is a little giant of value. Weighs up to 8600 lbs. as filled with water. Easy operation.

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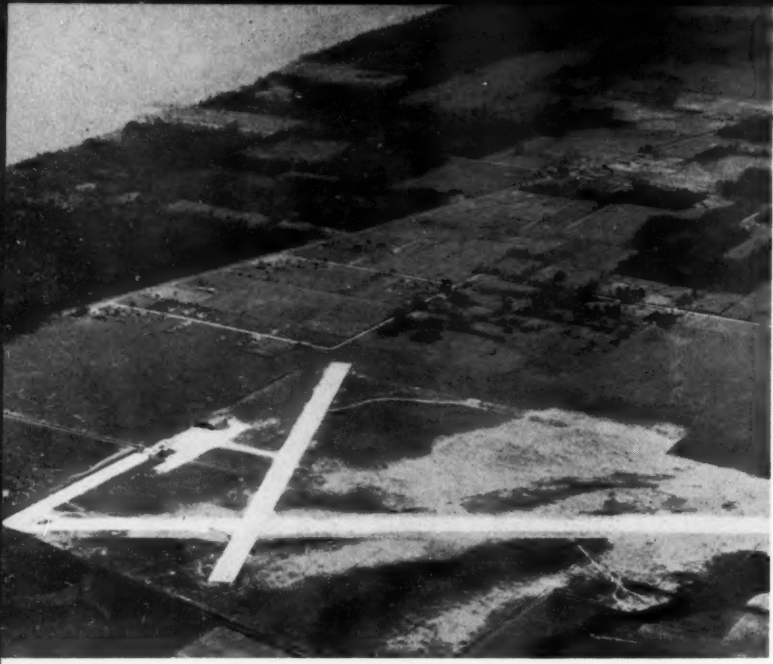


Layout of Mobile Airport. Mobile Bay in upper left.

Constructing Mobile Municipal Airport

By HARRY L. FISHER
City Engineer, Mobile, Ala.

DEVELOPMENT of the Mobile Airport (Bates Field) has been mostly done with Government relief forces during the past four years. Clearing, grubbing and grading were the first items to get under way, proceeding slowly as everything was done by hand labor, using wheelbarrows, shovels, etc. When the WPA was inaugurated, a comprehensive plan of grading was adopted, machinery was put into use, more men were added and work was speeded up. More than 80,000 cubic yards of grading was done.

Underground drainage was installed throughout the field and on account of the moisture-holding capacity of the soil the underground storm sewers were designed to carry both the storm water and to drain the subsoil. This was accomplished by leaving the joints uncaulked and filling around and over the pipe with cinders which were carefully compacted. This system has proved very effective as a continuous stream of water from the subsoil is running through the pipe even in our driest periods. A deep marginal ditch was constructed so that all surface water was deflected before reaching the airport and conveyed to natural drainage channels.

Work has been carried on efficiently as a WPA project. Exclusive of supervision and office force, the organization consists of two shifts for foremen, timekeepers and cement finishers. Laborers work three shifts. In this way work proceeds six days per week with comparatively little over-lapping of time. Each shift consists of 60 laborers, two shifts working at one time. The number is gradually reduced as the men become more proficient.

Three small trucks, two one-bag mixers and an ample supply of wheelbarrows and shovels comprise the equipment on the job.

A reserve supply of cement is stored in the hanger, and a reserve of aggregates kept at mixer locations. Daily deliveries of materials are made direct to the mixer. City water is piped to the mixer from the nearest main. The first concrete runway was 2400 ft. long, and 100 ft. wide.

The slab crown is six inches in 100 ft.—adequate, with a concrete surface, to provide good drainage but not enough to cause difficulty in handling planes during landings and take-offs. As the site is flat, this grade is provided by balancing excavation and filling.

Rough grading is done by 20 men under a foreman. After forms are set and a day or two before concreting, fine grading and tamping is done by a crew of ten men.

It was decided that the most economical procedure with hand concreting was to place 225-ft. lengths of the runways, with mixers located midway of this section. Starting at the center, 2 by 6-inch forms were set at 12½-ft. transverse spacing. This was done by two carpenters and two helpers.

Two concreting crews, with a mixer at each side of the center of the 225 ft. length, work from the center of the runway to the side. The crew starts concreting at one end and completes the paving to the center, then starts at the other end and again works to the center, completing the unit. Crews then shift to the next 12½ ft. strip and complete it, repeating the operation until they complete their half of the 100 ft. width.

On the first unit of each section one mixer is started a day ahead of the other so the longitudinal forms may be removed before the adjacent slab is placed. After the first strip is placed, one edge of the completed slab is used as a form.

Expansion joints are placed at 25-ft. intervals across the 12½-ft. strips; ¾-inch longitudinal expansion joints are also placed at 25-ft. intervals, leaving construction joints midway between each expansion joint.

The mixer crew consists of 23 men, including foremen, finishers and operators. A 1:2:4 concrete is used with enough water to give a 3-inch slump.

Curing is by wet earth, and continues for about ten days. Fourteen men and a foreman handle the details of curing the work of both concreting crews. This crew also builds the shoulders on each side of the runway and reconditions the adjacent field when cut up by trucks.

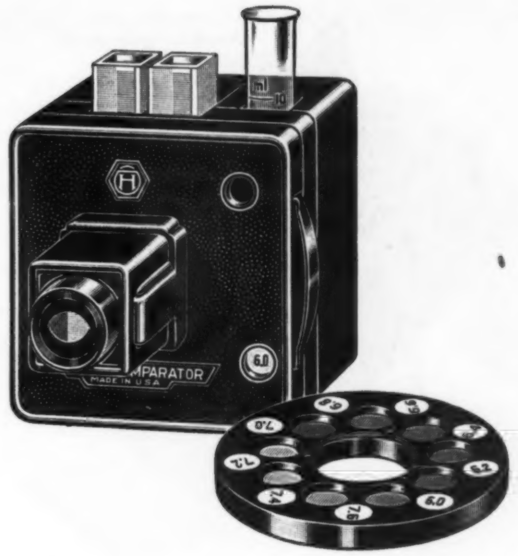
It was later decided that an additional concrete runway would be necessary in order to have a paved surface for all weather and wind direction conditions. Accordingly, a second concrete runway with a total length of 3200 feet was constructed.

After the runways were completed, additional fine grading was done on the field, top soil was placed where excavation and fills were made, and Bermuda grass planted thereon. A concrete taxi strip, 50 ft. in width, connects the runways with the concrete aprons at the adminstration building and hangar. The airport has been landscaped and is serviced with city water and sanitary sewers.

The landing field, consisting of 163.65 acres, is located four miles south of the business part of the city and is connected therewith by a paved highway.

The total estimated value of our airport is now approximately $300,000.

At the right is one type of a pH or hydrogen ion comparator for determining the intensity of alkalinity or acidity. This cut and cut on page 62, courtesy Hellige, Inc. Illustrations at bottom of this page courtesy W. A. Taylor.



Alkalinity and Acidity of Water

By W. A. HARDENBERGH

THERE are two methods generally used in measuring the alkalinity or acidity of water. One of these relates to the *intensity* and is commonly measured by means of pH comparators; the other is the *amount* of alkalinity or acidity in terms of grains per gallon or parts per million. Both are important in water treatment in that some information regarding them is necessary in softening water, in preventing corrosion of mains and distributing lines and red water production, and in coagulation.

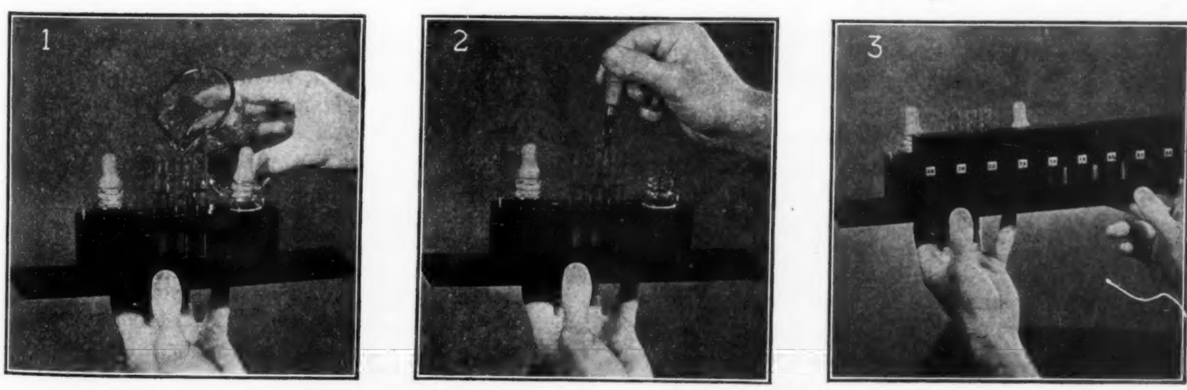
Alkalinity is caused by the presence of carbonates and bicarbonates in the water; some (but not all) of these also cause hardness. Hardness may also be caused by sulphates and chlorides, which do not affect the alkalinity. Therefore hardness and alkalinity are seldom the same. They will be the same when only calcium and magnesium carbonates and bicarbonates are present, these causing both hardness and alkalinity, but more often the other compounds also will be present.

Causes of hardness, alkalinity and acidity may be grouped as follows: Alkalinity, but not hardness, is caused by the carbonates and bicarbonates of potassium and sodium; both alkalinity and carbonate hardness are caused by calcium and magnesium carbonates and bicarbonates; non-carbonate hardness is caused by calcium and magnesium sulphates and chlorides, but these do not affect the alkalinity. Acidity is caused by organic or mineral acids, and acid salts. In addition, other salts may be present which may affect the value of the water for drinking purposes, but which do not relate to or affect either alkalinity or hardness, as iron, manganese and fluorides.

The determination of the *intensity* of alkalinity or acidity by the hydrogen ion concentration method is quite well known. This method is based on the color reactions of various chemicals with waters of different acidity or alkalinity. The test is best performed by using one of the several pH comparators on the market. A small amount of the water to be tested is placed in a tube—usually about 5 or 10 c. c.—and the color indicator is added. The color is then compared with glass or other standards. Thus pH determinations are extremely simple.

The pH scale ranges from 1 to 14; 7 is neutral. Numbers below 7.0 indicate acid water; above 7.0 alkaline waters. The acidity increases as the numbers become smaller: Thus 6.6 is acid; 5.8 more acid; 3.5 still more acid. Alkalinity increases as the pH numbers increase: Thus 7.6 is alkaline; 8.5 more alkaline and 10.1 even more alkaline.

In general, pH is determined to one decimal point only, as 5.6, 7.4, 8.2, or 9.3, with a color comparator.



MAKING DETERMINATIONS: 1. After removing the top of the base, three of the test tubes are placed in the holes back of the slots in the base and filled to the mark (5cc) with the sample to be tested. 2. To the central tube 0.5cc of the indicator solution is added, by means of the pipette and nipple, and the contents are thoroughly mixed. 3. The slide with the color standards is placed on the base and, holding toward the light, the slide is moved back and forth until a color match is obtained. The pH is read from the values on the front of the slide.

Another type of pH Comparator.

This determination of alkalinity does not give any indication of the *amount* of alkalinity that must be neutralized, except in conjunction with other tests.

The amount of alkalinity is determined by two rather simple tests that can be made by any waterworks operator with a small amount of laboratory apparatus. Before proceeding with a description of this, certain factors and relationships should be learned.

There are three common methods of measuring amounts of chemicals in water. These are: grains per gallon, commonly abbreviated g.p.g.; parts per million, abbreviated p.p.m.; and pounds per million gallons or lbs.p.m.g.

There are 7000 grains in one pound. A dose of 1 grain per gallon equals 1 pound in each 7000 gallons, or 1,000,000 divided by 7000 = 142.9 pounds per million gallon. A gallon of water weighs 8 1/3 pounds; therefore 1 grain per gallon, which equals 142.9 pounds per million gallons, also equals 142.9 divided by 8 1/3 = 17.1 parts per million. Thus

1 grain per gal. = 17.1 p.p.m. = 142.9 lbs. per m.g.
1 part per million = .058 g.p.g. = 8.33 lbs. per m.g.
1 pound per million gals. = .007 g.p.g. = 0.12 p.p.m.

When Imperial gallons are used, these figures change. The United States gallon equals 0.83 Imperial gallon. One grain per Imperial gallon equals 14.25 parts per million.

Common units of metric measurements used include the liter, equal to 1.0567 quarts, which contains 1000 c. c., or 100 milliliters, abbreviated m.l.; and the gram.

To determine the amount of alkalinity (usually called "alkalinity") the following apparatus is needed: 1 burette (a graduated glass tube provided with a stop cock and mounted on a small stand); a 200 c. c. erlenmeyer flask, and a 100 c. c. measuring cylinder. There is also needed a solution of phenolphthalein indicator, a solution of methyl orange indicator, and a solution of 1/50 normal (N/50) sulphuric acid. All of these can be purchased ready for use from chemical supply houses, so that no chemical knowledge and no materials or equipment other than that listed is needed.

To test, 100 c. c. (or m.l.) of the sample is placed in the erlenmeyer flask and four drops of the phenolphthalein indicator are added. The flask is shaken. If color appears, the water is alkaline. Add the sulphuric acid solution drop by drop until the color just disappears. The number of c. c. (or m.l.) of acid solution used should be noted. The alkalinity to phenolphthalein is 10 times the number of c. c. (or m.l.) required to cause the color to disappear. If 3.7 m.l. were required, the alkalinity to phenolphthalein is $10 \times 3.7 = 37$ p.p.m.

The sample already used for the phenolphthalein test can be used for the methyl orange alkalinity test; or a new sample of 100 c. c. can be used. To the sample is added 2 drops of the methyl orange indicator. If the solution becomes yellow, there is hydroxide, normal carbonate or bicarbonate present. The N/50 solution of sulphuric acid is added as before until the yellow color begins to turn to orange. The alkalinity to methyl orange in parts per million is equal to 10 times the number of c. c. (or m.l.) of sulphuric acid solution necessary to cause the color change. If 2.8 c. c. are required, the alkalinity to methyl orange is 28 p.p.m.

If the water is colored or turbid, erythrosine indicator may be used instead of the methyl orange. To 100 c. c. of water, 5 c. c. of neutral chloroform and 1 c. c. of erythrosine indicator are added. If the water is alkaline, the drops of chloroform will be pink; if the water is acid, they will be colorless. If pink, add standard N/50 acid solution until the drops lose their pink color. Ten times the number of c. c. of acid solution is the alkalinity. Alkalinity obtained by erythrosine is identical with that obtained by methyl orange.

The advantage of this method lies in the fact that the color change is noted by looking at the drops of chloroform, which are turned pink by erythrosine in alkaline water but are colorless in acid waters.

In most cases, the alkalinity determined by phenolphthalein and that determined by methyl orange or erythrosine will be quite different. This is natural, because these two tests measure different kinds of alkalinity, and between them give complete information on these different kinds of alkalinity. These are bicarbonate (HCO_3), carbonate or normal (CO_3) and hydroxide (OH) alkalinity.

Typical reactions that occur with each of these three types of alkalinity when sulphuric acid is added are:

Bicarbonate alkalinity:

$$2NaHCO_3+H_2SO_4=Na_2SO_4+2H_2CO_3 \quad (1)$$

Normal carbonate alkalinity:

$$2NaCO_3+H_2SO_4=NaHCO_3+Na_2SO_4 \quad (2)$$

$$2NaHCO_3+H_2SO_4=Na_2SO_4+2H_2CO_3 \quad (3)$$

Hydroxide alkalinity:

$$2NaOH+H_2SO_4=Na_2SO_4+2H_2CO_3 \quad (4)$$

Phenolphthalein gives a pink color only in the presence of hydroxide or normal carbonate alkalinity, or both, and when reactions (2) and (4) are completed, phenolphthalein turns colorless. Methyl orange or erythrosine changes to pink when reactions (1), (3) and (4) are completed. Thus phenolphthalein measures half of the normal carbonate and all of the hydroxide alkalinities, and methyl orange (or erythrosine) measures the total amount of all alkalinity.

Carbonate alkalinity is present above pH 8.3; bicarbonate alkalinity below pH 9.4; and hydroxide alkalinity above pH 9.4. When the pH is below 8.3, CO_2 dissolves the carbonates to form bicarbonates. When more sodium or calcium is added, bicarbonates are first changed to carbonates, and sodium or calcium in excess, remains as hydroxid.

The relationships between the three kinds of alkalinity, as determined by the phenolphthalein and methyl orange tests are shown in the following examples:

1. If the alkalinity to phenolphthalein is 0, that is, there is no color reaction to the addition of the phenolphthalein indicator solution, there is no caustic alka-

linity and no carbonate alkalinity, but the alkalinity to methyl orange as shown by the test represents the bicarbonate alkalinity.

Example: Alkalinity to phenolphthalein is 0.0 p.p.m.; and to methyl orange is 18.5 p.p.m. Caustic alkalinity is 0; carbonate alkalinity is 0; and bicarbonate alkalinity is 18.5 p.p.m.

2. When the alkalinity to phenolphthalein is less than one-half the alkalinity to methyl orange, there is no caustic alkalinity; the carbonate alkalinity is twice the phenolphthalein alkalinity; and the bicarbonate alkalinity is the methyl orange alkalinity minus twice the phenolphthalein alkalinity.

Example: Alkalinity to phenolphthalein is 28.0 p.p.m.; and to methyl orange 86.0 p.p.m. Caustic alkalinity is 0; carbonate alkalinity is 56.0 p.pm.; and bicarbonate alkalinity is 86—(2 x 28)=30.0 p.p.m.

3. When the phenolphthalein alkalinity is exactly one-half of the methyl orange alkalinity, the caustic alkalinity is 0, the carbonate alkalinity is the same as the methyl orange alkalinity, and the bicarbonate alkalinity is 0.

Example: Phenolphthalein alkalinity is 72.0 p.p.m. and methyl orange alkalinity is 144.0 p.p.m. The caustic alkalinity is 0.0 p.p.m.; the carbonate alkalinity is 144.0 p.p.m.; and the bicarbonate alkalinity is 0.0 p.p.m.

4. When the phenolphthalein alkalinity is more than one-half of the methyl orange alkalinity, caustic alkalinity is twice the phenolphthalein alkalinity minus the methyl orange alkalinity; the carbonate alkalinity is twice the difference between the phenophthalein and methyl orange alkalinities; and the bicarbonate alkalinity is 0.

Example: The phenolphthalein alkalinity is 150 p.p.m.; the methyl orange alkalinity is 196 p.p.m. The caustic alkalinity is 2 x 150—196=104 p.p.m.; the carbonate alkalinity is (196—150) 2=92 p.p.m.; bicarbonate alkalinity is 0.

5. When the phenolphthalein and methyl alkalinities are the same, all the alkalinity is caustic alkalinity and carbonate and bicarbonate alkalinities are 0.

Example: Phenolphthalein alkalinity is 120: alkalinity to methyl orange is 120. Hydroxide alkalinity is 120, and carbonate and bicarbonate alkalinities are 0.

Other Tests

To obtain the free CO_2 content of the water, the same apparatus is required as for determining alkalinity; also the phenolphthalein indicator and a solution of N/44 sodium hydroxide, which can be purchased ready for use. To 100 c.c. of sample, 10 drops of the phenolphthalein indicator are added and then the sodium hydroxide solution, drop by drop, stirring the sample meanwhile, until a faint pink color is produced. The free CO_2 in parts per million calcium carbonate equals 10 times the number of c.c. of the N/44 sodium hydroxide solution used. If an N/50 solution is used, the multiplier is 8.8.

The total acidity is obtained by adding 4 drops of the phenolphthalein indicator to 100 c.c. of the water, which has been placed in a white dish or in a flask on a white surface. The N/44 sodium hydroxide solution is then added until a pink color is obtained. The total acidity in parts per million of calcium carbonate equals 11.4 times the c.c. of sodium hydroxide used. If an N/50 solution is used instead of the N/44, the multiplier is 10 instead of 11.4.

Acidity is reported as the parts per million of calcium carbonate. Sulfate (SO_4) equals the calcium carbonate, in parts per million, multiplied by 0.96.

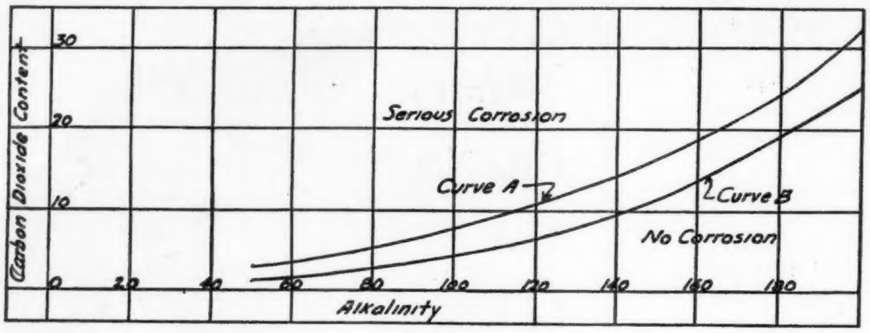
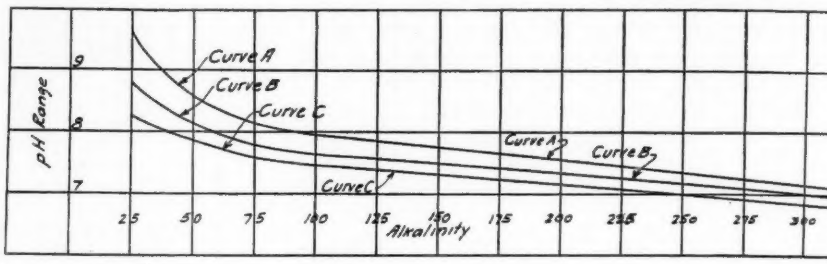


Fig. 1, at left, shows relation between corrosion, alkalinity and CO_2. Values for CO_2 and alkalinity falling below curve B do not cause corrosion. Between the two curves there is approximate calcium carbonate equilibrium. Above curve A serious corrosion is indicated. Fig. 2, below, shows relation between pH, alkalinity and corrosion. If pH and alkalinity values fall above curve A, calcium carbonate will be deposited. If above curve B, but below A, a calcium carbonate equilibrium is maintained. Between curves B and C, corrosion is negligible. Below curve C, corrosion will occur.



Cost of Equipment for Tests.—The burette (50 c. c. capacity, with 1/10 c. c. graduations, and a stopcock), the burette support, a 100 c. c. cylinder, 6 erlenmeyer flasks, the indicators and the acid solution for determining alkalinity, will cost about \$10. This is all that is necessary for determining alkalinity. For determining acidity, additional equipment will cost about \$3, unless it is desired to have a somewhat more elaborate burette. The white porcelain dish is the only added equipment needed for the carbon dioxide determination. A very good set can be purchased, that will be suitable for all these tests, for about \$15.

In addition, a pH comparator and a copy of Standard Methods of Water and Sewage Analyses should be available. The cost for this pH set depends somewhat on the type selected. For \$35 to \$50 it is possible to purchase the pH set, Standard Methods, and all of the equipment listed above.

Corrosion

Cause of Corrosion.—The actual cause of corrosion is the dissolved oxygen in the water (except in pH ranges below 5.5 when there may be acid corrosion). The extent of corrosiveness depends on the pH value, the CO_2 content, the alkalinity and the mineral content. It can be prevented by the removal of the dissolved oxygen or by placing a protective coating or film on the pipes. Removal of the dissolved oxygen is not feasible or desirable, so that corrosion is best prevented by adjusting the mineral content and the pH of the water so that deposits of alkaline salts form on the pipe walls and prevent corrosion.

Most waters contain alkaline salts (usually calcium and magnesium bicarbonates), and by controlling the pH and the CO_2 these can be deposited as desired. CO_2, when present in considerable amounts, holds these alkaline salts in solution, preventing any deposits. Excess of CO_2 increases the corrosiveness of the water.

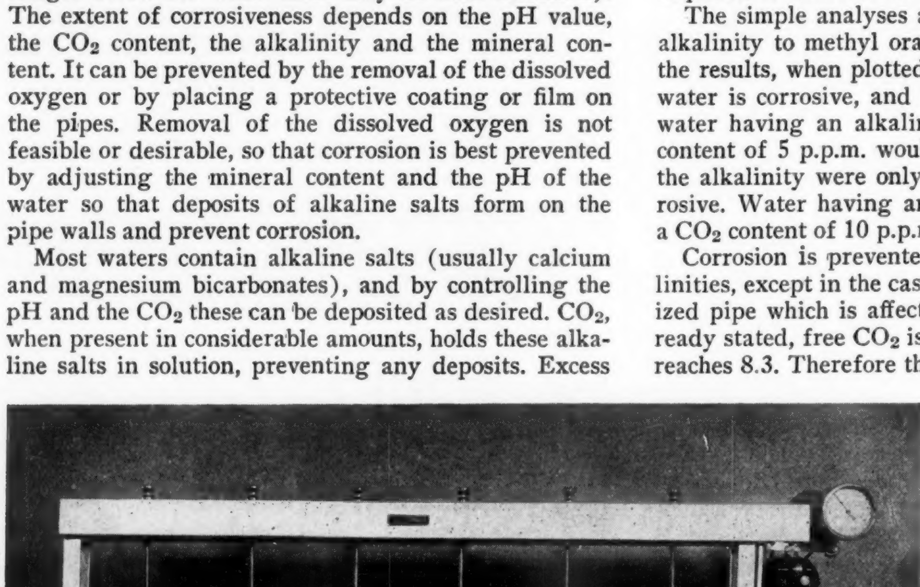
Control of CO_2 content, and consequent prevention of corrosion, is best accomplished by adding an alkali, as lime or soda ash, to the water, lime being most generally used because of its economy.

The amount of alkali required depends upon the pH content of the water. Free CO_2 is eliminated when the pH value reaches 8.3; alkaline waters with a pH value of 7.5 are but little, if at all, corrosive. The relation between alkalinity, CO_2 content and corrosiveness is well illustrated by the chart shown in Fig. I, which is based on a similar chart in Water Supply Control, by C. R. Cox, published by the New York State Department of Health. This shows that waters of low alkalinity are corrosive when the CO_2 content is relatively low, but that as alkalinity increases, the amount of CO_2 required to cause corrosion increases quite rapidly.

The simple analyses already described for CO_2 and alkalinity to methyl orange should be performed, and the results, when plotted on this chart, will show if the water is corrosive, and to what extent. For instance a water having an alkalinity of 100 p.p.m. and a CO_2 content of 5 p.p.m. would be slightly corrosive; but if the alkalinity were only 50, it would be seriously corrosive. Water having an alkalinity of 150 p.p.m. and a CO_2 content of 10 p.p.m. would not be corrosive.

Corrosion is prevented by high pH and high alkalinities, except in the case of the zinc coating of galvanized pipe which is affected by high pH values. As already stated, free CO_2 is eliminated when the pH value reaches 8.3. Therefore the most effective means for preventing corrosion is increasing the alkalinity and pH. This is done by adding a soda ash or lime.

The Chart, Fig. 2, which is also adapted from Water Supply Control by Cox, shows the relationships between pH and



This illustrates equipment especially designed for making the tests described on page 65. The heaters are 1000 C.C. pyrex. The stirring equipment can be run at any desired speed. Illustration courtesy Phipps and Bird.

alkalinity in terms of corrosiveness. On this, three curves are shown, A, B and C, which illustrate three stages or phases, as follows:

If it is desired to treat the water sufficiently to prevent the formation of iron stains by the water, but to permit a mild degree of corrosion, the pH and alkalinity content should fall along the curve C. So long as the relationships shown by this line exist, serious corrosion will not occur.

If it is desired to prevent any corrosion, but not to cause any deposit of calcium carbonate on the piping, pH and alkalinity values should be maintained as shown by Curve B.

When it is desired to build up a protective coating of calcium carbonate on the pipes, values of the pH and calcium carbonate content should be as shown by Curve A. If the values indicated by this curve are much exceeded excessive deposits may form.

Thus, water with a pH of 7.5 and an alkalinity of 100 p.p.m. would have a calcium carbonate equilibrium, and would neither deposit, nor be corrosive; but if the alkalinity were only 75 p.p.m., the water would be slightly corrosive. If the alkalinity were 75 p.p.m. and the pH 8.3, there would be deposited a coating of calcium carbonate. As the alkalinity increases, there is equilibrium with lower pH values. But at pH 7.0, most waters are corrosive. The alkalinity would have to be very high at this pH to prevent red water troubles—about 225 p.p.m.

There are several methods of determining the amount of lime or soda ash required to prevent corrosiveness. The simplest method, which does not require the determination of the alkalinity, is by means of the marble test. In this, a sample of the water is placed in a bottle having a wide mouth, or in a beaker, and several pieces of pure calcium carbonate (also called calcite) are added. This calcium carbonate is dissolved by the CO_2 present in the water, being changed to bicarbonates, as follows:

$CaCO_3$	+	CO_2	=	$CaCO_3CO_2$
Calcium carbonate		Carbon dioxide	=	Calcium bicarbonate

This reaction continues until all of the corrosive elements have been neutralized by the calcium carbonate, during which time the pH value increases. The pH value of the water containing the calcite should be determined from time to time; when it no longer increases but remains constant, the water has absorbed enough calcium carbonate for equilibrium, as shown by the curve B, Fig. pHC. It is then only necessary to add lime to the water to be treated in quantities sufficient to raise the pH to the mark shown by the marble test.

It is desirable, at times, to compute the quantity of lime that will be required, per million gallons. This can be done by adding to a number of samples of the untreated water varying quantities of lime, to determine the amount needed to raise the pH of the water to that shown as being necessary by the marble test.

The procedure is as follows: In four or six jars are placed measured quantities of the water—usually 500 or 1000 m.l. when using the metric system; or 1 quart. (While fruit jars may be used and necessary stirring done by hand, special mixing apparatus is handier.) To the water in the jars or containers is added lime or soda ash solutions in various amounts, and determination made as to which quantity produces the desired pH reaction.

Making the Solutions

Lime.—Using 1 liter of distilled water, add 1 gram of lime. One ml. of this solution, when added to one

liter of the water to be treated is equal to a dose of 1 p.p.m. This assumes a 100% strength of CaO, which is seldom the case. If the strength of the lime is known, vary accordingly; if not known, assume a CaO content of 88% and use about 1.14 grams.

If it is desired to use 1 quart samples instead of 1 liter samples, add 0.95 grams to a liter of water; 1 ml. of this solution added to 1 quart of water is equal to a dosage of one p.p.m. Vary according to the CaO content of the lime.

Soda Ash.—Soda ash is usually 98% strength. Using this as a basis, 1.02 grams of soda are added to 1 liter of distilled water. One ml. of this solution, when added to 1 liter of the water to be treated, is equal to a dose of 1 p.p.m.

Dosages in Grains Per Gallon.—To prepare a solution for dosages in grains per gallon, add 17.1 grams of the chemical to 1 liter of distilled water. One ml. of the solution, when added to 1 liter of the water to be treated equals a dosage of 1 grain per gallon. Allowance must be made for the strength of the chemical. Using soda ash, 98%, the dosage will be $1.02 \times 17.1 = 17.44$ grams. With 88% lime, use 19.48 grams instead of 17.1 grams.

Procedure.—To each of six (a lesser number can be used) jars containing 1 liter of the water to be treated, add varying dosages of lime or soda ash. For instance, using the solution for grains per gallon, add to the first jar 1 ml., equalling a dose of 1 grain per gallon; to the second 1½ ml.; to the third 2 ml., etc. The sixth jar will have received 3½ ml., representing a dose of 3½ g.p.g. Test each of the jars for pH. The jar which shows a pH most nearly that resulting from the marble test indicates the approximate dosage. This dosage of chemical should then be applied to the raw water and the resulting pH noted.

When the alkalinity and CO_2 content are known, the amount of lime or soda ash necessary can be computed. The free and the half-bound CO_2 (the latter equals 44% of the alkalinity) must be removed by combination with lime or soda ash. Theoretically 1 grain per gallon of lime (100 CaO) will react with 13.75 p.p.m. of carbon dioxide. On the basis of 88% CaO content, about 11.9 p.p.m. will be removed by each g.p.g.

When soda ash of 98% strength is used, 1 grain per gallon will combine with 7.2 p.p.m. of carbon dioxide.

Example.—An analysis of the water shows the following characteristics:

Free CO_2	10 p.p.m.
Methyl Orange alkalinity	90 p.p.m.
Phenolphthalein alkalinity	0 p.p.m.

As previously stated, this analysis indicates all alkalinity is in the form of bicarbonates. The half-bound CO_2 is therefore 44% of 90 or 39.6 p.p.m. Lime required to react is computed as follows:

Free CO_2	10 p.p.m.
Half-bound CO_2	39.6 p.p.m.
	49.6 p.p.m.

$$49.6 \div 13.75 = 3.6 \text{ grains of CaO per gallon}$$

Using 95% hydrated lime (hydrated lime is about 75.7% CaO), 1 grain per gallon will react with about 9.6 p.p.m. of CO_2. The dosage would then be:

$$49.6 \div 9.6 = 5.2 \text{ g.p.g.}$$

Using 98% soda ash, there would be required $49.6 \div 7.2 = 6.9$ p.p.m.

[*Ed. Note.* Other articles will be published from time to time treating the application of alkalinity in water softening and in water treatment. Questions regarding material covered in this article, or in relation to readers' problems, will be answered.]

NEWS FROM THE FIELD

American Water Works Association

General and sectional meetings have been announced as follows:

June 7-11: A.W.W.A. Annual Convention, Statler Hotel, Buffalo, N. Y.

August 18-20: Central States Section, Dearborn Inn, Dearborn, Mich.

August 26-28: North Carolina Section, Cape Fear Hotel, Wilmington, N. C.

September 20-22: Rocky Mountain Section, La Fonda Hotel, Santa Fe, N. Mex.

October 11-14: Southwest Section, Austin, Tex.

October 20-23: California Section, Senator Hotel, Sacramento, Calif.

October 28-30: Minnesota Section, St. Paul, Minn.

November 4-6: Virginia Section, Richmond, Va.

November 4-6: Missouri Valley Section, Fontenelle Hotel, Omaha, Nebr.

November 8-10: Wisconsin Section, Hotel Northland, Green Bay, Wisconsin.

Pennsylvania Sewage Works Association

The Eleventh Annual Conference of the Pennsylvania Sewage Works Association will be held at State College, Pa., June 21st, 22nd and 23rd in the auditorium of the Home Economics Building.

Registration will begin at 1:00 P. M., Monday, June 21st; that evening at 7:00 o'clock, will be held the first gadget display; following this will be Professor L. V. Carpenter's paper on "Things the Operator Should Know."

At the Tuesday morning session, there will be two papers presented, one by William C. Emigh on "Starting and Operating the Coatesville, Pa., Sewage Treatment Works"; and the other by John C. Geyer on "Effect of Industrial Waste on Sewage Treatment Plant Operation." Following the latter paper, there will be a short business session.

The entire Tuesday afternoon session will be devoted to a "Sewage Works Clinic" under the leadership of Harry M. Freeburn. At this Clinic, Freeburn will be assisted by such eminent sewerage *physicians* as Professor R. O'Donnell, Grant M. Olewiler, E. M. Jones, L. L. Langford, Gordon J. Wiest, Harry Hancock and William A. Ryan.

Tuesday evening at 7:00 o'clock there will be the Annual Dinner at the Nittany Lion Hotel, under the direction of H. E. Moses. The guest speaker will be Elwood J. Turner, Vice Chairman, The Interstate Commission on the Delaware River Basin.

At the Wednesday morning session three technical papers will be presented. The first, by Robert W. Haywood, Jr., "Activated Carbon—Its Place in Sewage Treatment"; the second, by H. Heukelekian, on "Bio-Floculation of Sewage," and the last, by L. H. Enslow, on "Aspects of Sewage Chlorination in 1937."

D. D. Williamson

D. D. Williamson, formerly head of the Texas State Highway Laboratories, has been placed in charge of the new Dallas office of the Asphalt Institute.

W. H. Pape is the manager of the newly formed Valve and Fitting Dept., of the Crane Co., Chicago. All estimating, engineering and sales of valves, fittings, pipe, etc., are handled by this new department.

Stanley I. Pinel, formerly principal engineer of the Department of Research and Service, Louisville, Ky., has joined the staff of the American Public Works Ass'n.

New Publications

Armco Multi Plate Bridges:

This is a 16-page, 8½x11 booklet, recently published by the Armco Culvert Mfrs. Association, Middletown, Ohio. A number of views of single, twin and triple arch bridges and a large pipe structure have been reproduced in five colors to show the possibilities of this type of construction from a beauty standpoint. The utility side is also stressed. Copies free from Armco Culvert Mfrs. Association, Middletown, Ohio, or any of its member companies throughout the United States and Canada.

Steel Grandstands:

A 4-page folder gives some nice views of all-steel grandstands and lists the seating capacities for various standard sizes—up to 14,400. Sent on request to Pittsburgh-Des Moines Steel Co., Neville Island, Pittsburgh, Pa.

Shallow Well Water Systems:

Roots-Connersville Blower Corp., Connersville, Ind., describes its shallow well water systems, 300 to 4200 gallons per hour, turbine pump, in Bulletin 260-B13B, which will be sent on request.

Pump Data:

A new handbook for the solution of pumping problems is available from Economy Pumping Machinery Co., Chicago, Ill. There are 11 chapters, covering what kind of a pump, horsepower needed, cost of pump, motor and motor controls and how to order and specify; also hydraulics of pumping and related material and tables. Sent on request.

Tow-Bro Sludge Remover:

An excellent catalog, 20 pp., illustrated with numerous installation photographs, drawings and plans, and containing data on the efficiency of the units installed at Milwaukee is available from Chain Belt Co., Milwaukee, Wisc.

Motorpumps:

Ingersoll-Rand Company, 11 Broadway, New York, N. Y., has just issued a new catalog describing its Cameron Motorpumps. These combine electric motor and centrifugal pumps in a single unit. Capacities range from 5 to 1000 gallons per min. for heads to 500 ft. Motor sizes range from ¼ to 40 HP.

Caterpillar Diesel Tractor:

The Caterpillar diesel RD7 tractor, 20,980 pounds weight, is fully described in a 32-page catalog that is attractively and instructively arranged. Sent on request. Caterpillar Tractor Co., Peoria, Ill.

Fairbanks, Morse Pumps & Engines

Characteristics and applications of duplex power pumps are discussed in detail in Fairbanks, Morse Bulletin 6160, 16 pp.; also uses, power combinations, etc. Diesel engine applications are described, illustrated and discussed in a very attractive booklet. Either or both on request to Fairbanks, Morse & Co., 900 So. Wabash Ave., Chicago, Ill.

Austin-Western Equipment:

A pictorial catalog featuring Austin-Western equipment in operation; 24 pp. Covers road-making, earth handling, rock crushing, and street cleaning equipment. Sent on request to Austin-Western, Aurora, Ill.

Asphalt and Tar Distributor:

A new catalog by Littleford Bros., Cincinnati, O., covering their new Model "C" pressure distributor. It also contains considerable data of value and interest to users or potential users of distributors. Sent on request.

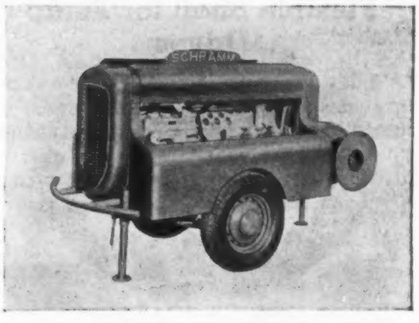
A Handy Roller:

A 2-ton general utility roller for bituminous patching, shoulder work, sidewalks and driveways is made by C. H. & E. Mfg. Co., 3849 No. Palmer St., Milwaukee, Wisc. This is described fully in Bulletin 237, which will be sent on request.

CO_2 Meters:

Brown Instrument Co., Philadelphia, Pa., have available an excellent catalog, No. 3005, which covers indicating and recording CO_2 meters, and temperature recorders. 24pp.

New Equipment



The Schramm DeLuxe Compressor in Trailer Mounting

The New Littleford Model "C" Distributor

The New Littleford Model "C" Bituminous Distributor was the first to introduce the idea of instant cut-off at the spray bars by applying the full force of the suction side of the material pump on the lines, sucking the bitumen in the lines back into the tank.

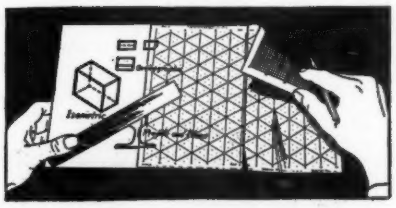
The 1937 Littleford Model "C" adds to this principle by the use of special suction fittings on the manifold bar and spray bars that prevent the entrance of air through nozzles from breaking the suction until the lines are emptied. This gets rid of bothersome dribble from the bars after cutting off the spray.

Other new features on this New Model "C" includes a specially designed hood over the spray bars that shields operator and pumping engine from dust, fumes and fog. Streamlined rear wheel fenders protect operator and machine from bitumen, dust and chips thrown by the tires.

The spray bar raises to give ample road clearance between shots. This also helps when applying a "fog" shot. Dust caps seal the spray bar feed lines against dust and stones while spray bars are removed.

The Littleford low pressure burner and continuous heat flue has been improved by the use of a special highly heat resistant alloy casting for the combustion tube and flue liner. In addition to these new features, the basic ideas of the Model "C"—the single valve, the crosswise mounting of the pumping engine to cut down overhang, the use of rock wool for insulation, the heat chamber for quick thawing out of pump, valve and lines, the 16 x 4 pneumatic tired fifth wheel tachometer drive and pump tachometer have been worked over with minor changes for the operator's convenience.

A new bulletin explains this new distributor in minute detail. It will be sent on request to Littleford Bros., 452 E. Pearl Street, Cincinnati, Ohio.



Wade Sketch Pad Set

Handy Sketch Pad Set

This set consists of a pad of tracing paper with a stiff card back, sealed on two edges; a guide plate, and a steel straight edge. The buff colored guide plate is printed in blue showing an Isometric design and an 8x8 to the inch pattern. Any type of drawing can be made to any scale as illustrated. The guide plate is moisture, dirt and crack proof, and is easily cleaned. Wade Instrument Co., 2246 Brooklyn Station, Cleveland, O.

Schramm DeLuxe "Utility" Compressor

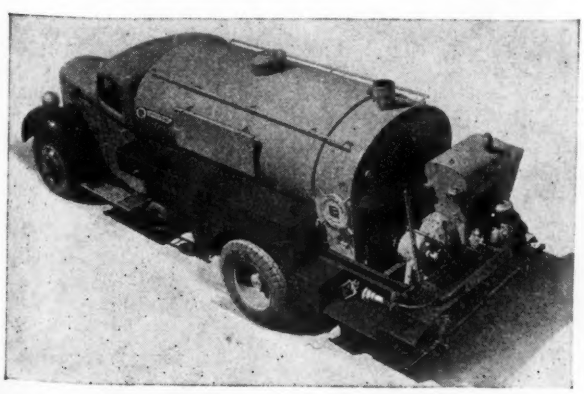
Schramm Inc., West Chester, Penna., have announced a new, lightweight air compressor. Two of the standard Schramm "Utility" models have been engineered into DeLuxe models to meet the need for a compact, lightweight, portable air compressor. This DeLuxe machine is available in sizes 85 and 105 cu. ft. actual air delivery in the gasoline engine driven machines and in the 105 cu. ft. size in the Diesel powered unit.

Compressor features include four cylinder, vertical block with lighter pistons; five main bearings; force feed lubrication supplied by gear driven oil pump to all movable parts; mechanical intake valves operated from camshaft in timing with piston travel; electric self-starting, and the Schramm self-aligning clutch between engine and compressor.

The DeLuxe "Utility" is a complete air plant with air and gas tanks compactly under the hood. This machine represents a saving of some 1500 pounds in weight and means a saving in transportation costs because the unit can be mounted on a ½ or ¾-ton truck.

Two portable mountings are available in the form of a two wheel pneumatic tire spring trailer which can be towed at speeds up to forty miles per hour and the truck mounted DeLuxe which results in a streamlined, portable outfit. DeLuxe features also include two spacious, streamlined tool boxes on either side of the machine. "Live-air" hose reels can be furnished as extras on DeLuxe Models.

Bulletin No. 3700-PM contains full data. It will be sent on request to Schramm Inc., West Chester, Pa.



New Littleford Distributor, Model "C."

Right: This tests for and measures the intensity of odors

Osmoscope for Testing Odors

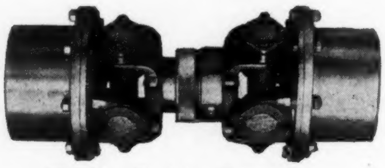
Determination of the intensity of odor or pO value with this instrument employs the air-dilution method, and measurement is very simply accomplished. Tests should be conducted in a room where the air is relatively fresh and uncontaminated by odors. Insert the instrument deep into the flask containing the odor-saturated atmosphere. If no odor can be detected, move the sleeve upward until the figure 5 becomes visible and so on until the odor is just detectable.

The intensity of the odor is determined by the figures on the side of the Osmoscope. They represent the pO values. If no odor is noticeable in 6 position, but odor can be detected in the 5 position, the pO value is 5. If no odor can be detected in the 1 position, but odor can be sensed in the O position, the pO is O. The concentration of odor-producing constituents for a pO reading of 5 is 32 ($2^5=32$); for a pO reading of O it is 1 ($2^0=1$). If no odor is detectable in the O position, the substance is odorless and has no pO or threshold value. Should the odor intensity (pO) of a liquid exceed 6, it is possible to dilute the liquid with some suitable material in the ratio of 1 in 64 ($2^6=64$) and again observe the odor with the Osmoscope. This initial dilution must be taken into account in reporting odor intensities.

This equipment is supplied by Eimer & Amend, Third Avenue, 18th to 19th Streets, New York, N. Y. Folder and directions on request.

Flexible Shaft for Pump Drives

The Watson-Spicer flexible shaft provides an unusual degree of alignment flexibility for driving deep well turbine pumps from engines and for electric driven vertical sewage pumps. Its construction is entirely of metal and makes



Flexible Shaft for Pump Drive

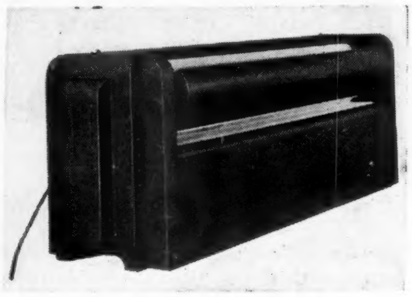
use of four sets of needle-bearings to avoid friction losses and prevent whining at higher speeds. On new installations, it is claimed that costly lining up of pumps and motors becomes unnecessary as do heavy sub-bases usually used to maintain alignments. The flexibility will permit a turbine pump to settle five inches and tilt one inch before resetting becomes necessary.

Several Watson shafts may be coupled together for driving vertical sewage or pit pumps. This simple solution for an otherwise complicated and costly alignment of bearings operates entirely free of vibration. Added information is available from H. S. Watson Company, 1145 Harrison Street, San Francisco.

Bruning Printer Black-Line Prints

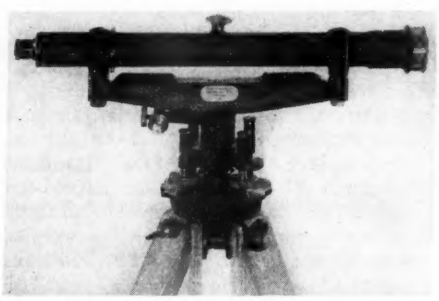
A simple, compact, continuous printer, for exposing BW black-line paper or blue-print paper, is announced by Charles Bruning Company, Inc., 102 Reade Street, New York, N. Y. The machine, which is built for 100 A.C. and 110 D.C., exposes paper of any width up to and including 42 inches. It plugs into any light socket and consumes much less current than the usual arc lamp machines.

Used in conjunction with the Bruning black and white developing machine, the new Bruning BW Printer provides a simple means of producing black-line prints from tracings or drawings. After the paper has been exposed in the new BW Printer, the print is developed instantaneously in any regular BW Developing Machine and is immediately ready for use. The prints need no washing or drying.

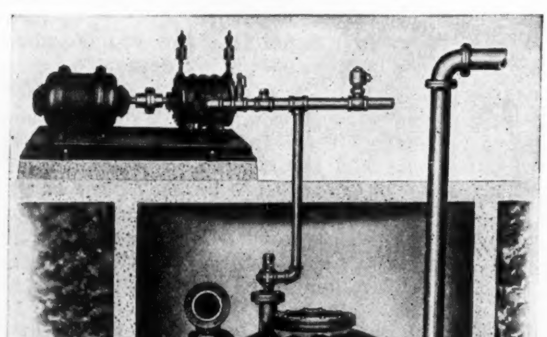


Bruning Black Line Printer

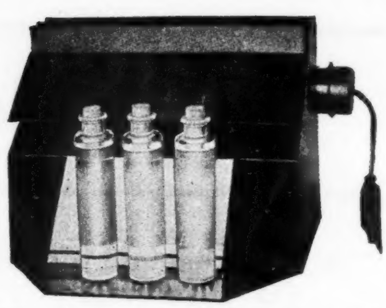
According to the Bruning Company, a single operator can print and develop two to three 50-yard rolls of black-line paper per day.



This is the new 18" Engineer's Dumpy Level, just announced by Warren-Knight Co., 136 No. 12th St., Philadelphia, Pa. Compact; stream-line design. Internal focusing; U. S. Standard thread. 64-page catalog of transits and levels on request.



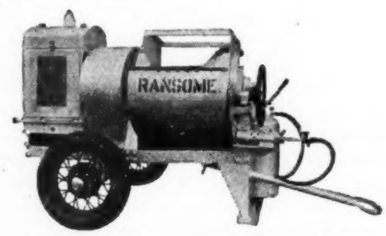
The Yeomans-Shone sewage ejector shown above is described in Bulletin 4050, published by Yeomans Bros. Co., 1433 Dayton St., Chicago, Ill.



This is the Clark Clarity Tester, useful where cloudiness or turbidity are important. Write Laboratory Equipment Co., 148 Lafayette St., N. Y., for information

Ransome Hot or Cold Patch Bituminous Mixer

Ransome Concrete Machinery Co., Dunellen, N. J., has announced a 6 and 10 cu. ft. mixer for handling the hot or cold patch bituminous mixtures for surfacing and maintenance of roads, driveways, airport runways, walks, playgrounds, etc.

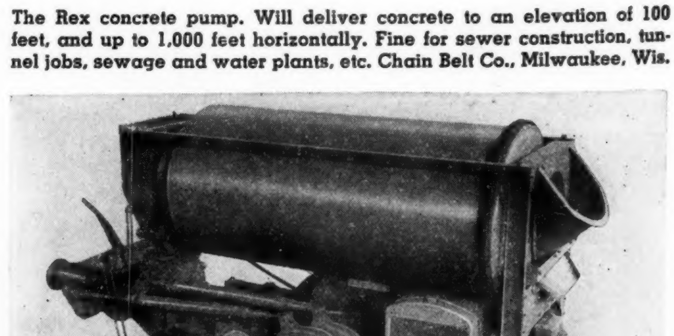


Hot or Cold Patch Bituminous Mixer

With this bituminous mixer, it is said to be possible to heat and obtain a thorough and uniform mix of sand, pit run gravel, pea gravel, crushed rock, as well as any patented bituminous patching material.

Mixing is accomplished by two large steel paddles, which revolve at 26 R.P.M. The drum is supplied by a 10-gallon capacity fuel tank and improved type Littleford burner. The mixer is available in two sizes—6 cu. ft. and 10 cu. ft., mounted on trailer mountings with steel or pneumatic tired roller bearing wheels with coil springs.

The Rex concrete pump. Will deliver concrete to an elevation of 100 feet, and up to 1,000 feet horizontally. Fine for sewer construction, tunnel jobs, sewage and water plants, etc. Chain Belt Co., Milwaukee, Wis.



Readers' Service Department

CONTINUED FROM PAGE 72

These booklets are FREE to readers of PUBLIC WORKS.

Cast Iron Sewers

385. For use in wet ground to prevent infiltration, for crossing under railways and heavy duty highways, and for all other sewer construction where replacement, repairs or reconstruction would be costly, cast iron pipe is most economical. For details, specifications, etc., write Thomas F. Wolfe, Cast Iron Pipe Research Ass'n, 1013 Peoples Gas Bldg., Chicago, Ill.

Couplings for Pipe

386. This sixteen-page booklet is a reprint of a magazine article by a consulting engineer. It describes in detail the installation of a 42" water line; contains specific information regarding pipe joints, field organization, laying pipe, tests, back-filling, etc. Sent free by S. R. Dresser Manufacturing Company, Bradford, Pa.

Feeders, Chlorine and Chemical

387. For chlorinating small water supplies, swimming pools and other installations. Flow of water controls dosage of chlorine (or other chemicals) providing required dosages, which are immediately adjustable. Driving is started and stopped automatically. Send for newest literature. %Proportioneers%, 9 Codding St., Providence, R. I.

Fire Hydrants

388. Two new bulletins on M-H fire hydrants and fully bronze mounted gate valves are now ready. Contain full specifications and instructions for ordering, installing, repairing, lengthening and using. Write M. & H. Valve & Fitting Co., Anniston, Ala.

Gate Valves

390. 28 page catalog contains illustrations and complete specifications of M-H standard and extra heavy iron body gate valves, horizontal swing check valves, flanged fittings and flanges, etc. Sent promptly on request by M. & H. Valve & Fittings Co., Anniston, Ala.

Manhole Covers and Inlets

403. Nuisance from loose, noisy manhole covers is eliminated by the use of Westeel rubber cushioned manhole covers and gratings. Six special advantages are explained in a new illustrated bulletin just issued by the West Steel Casting Co., 805 East 70th St., Cleveland, Ohio.

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter, crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Pipe, Cast Iron

406. Data on cast iron pipe for water works systems, in sizes from 1¼ to 84 inches, including information on useful life, flow data, dimensions, etc., Thos. F. Wolfe, Cast Iron Pipe Research Ass'n, 1013 Peoples Gas Bldg., Chicago, Ill.

Pipe, 2-inch Cast Iron

407. The new McWane 2" cast iron pipe in 18-foot lengths has innumerable uses in water and sewage work. Send for the new McWane bulletin describing this pipe, the various joints used, and other details about it. McWane Cast Iron Pipe Co., Birmingham, Ala.

Pipe, Steel

408a. A very complete, 60 page, illustrated bulletin on spiral welded pipe including lots of useful engineering information, hydraulic data, flow charts, specifications, etc., issued by American Rolling Mill Co., Pipe Sales Div., 1101 Curtis St., Middletown, Ohio.

Pipe Forms

409. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe Joints

410. New folder describes in detail a new type of pipe joint—the Dresser Compression Coupling, Style 65, which is compact and self contained, makes a permanently tight joint under all conditions and is installed on plain end pipe in a few seconds with only one tool, a wrench. Get your copy today. S. R. Dresser Mfg. Co., Bradford, Pa.

Pipe Joint Compound

411. A new bulletin has recently been issued giving full details concerning Tegul Mineralead, a quick-sealing, trouble-free compound for bell and spigot joints which permits immediate closing of the trenches. Write The Atlas Mineral Products Co. of Pa., Mertztown, Pa.

412. New plastic sewer pipe joint compound, Servitite, contains chemicals which positively prevent root growth and gives watertight joint. Get complete information from Servicised Products Corp., 6046 West 65 St., Chicago, Ill.

Taste and Odor Control

413. How, when, and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a new booklet just issued by Industrial Chemical Sales Div., 230 Park Ave., New York, N. Y. 32 pages, table, illustrations and usable data.

414. Information on activated carbon for taste and odor control including data on operating experiences. Write L. A. Salamon & Bro., 216 Pearl St., New York, N. Y.

Pumps and Well Water Systems

415. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps, fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for these three descriptive booklets. Layne & Bowler, Inc., Dept. W, General Office Memphis, Tenn.

Protective Pipe Coating

416. Coal-tar Pitch Enamels for exterior and interior linings for steel water lines; highly resistant to water absorption, soil acids and alkalis. Technical specifications for materials and their application will be sent on request. The Barrett Company, 40 Rector St., New York, N. Y.

Pumping Engines

417. "When Power Is Down," gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Run-off and Stream-Flow

420. Excellent booklet describes and illustrates the latest types of instruments for measuring run-off, both from small areas for storm sewer design, and from large areas for determining water shed yield. Sent promptly by Julien P. Friez & Sons, Baltimore, Md.

Screens, Sewage

421. The simple, automatic Laughlin self-cleaning, traveling screen is fully described in an interesting bulletin issued by Filtration Equipment Co., 10 East 40th St., New York, N. Y.

423. Be asurred of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straight-line Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Avenue, Chicago, Ill.

Setting and Testing Equipment for Water Meters

424. All about setting and testing equipment for Water Meters—a beautifully printed and illustrated 40 page booklet giving full details concerning Ford setting and testing apparatus for all climates. Ford Meter Box Co., Wabash, Ind.

Rainfall Measurement

429. The measurement of precipitation, exposure of gauges, description of apparatus for measuring rainfall, both rates and amounts. Bulletin RG and Instruction Booklet. Julien P. Friez & Sons, Baltimore, Md.

Screens

430. Water Screen Book No. 1252, describes traveling water intake screens and gives complete technical information about them. Link-Belt Co., 307 No. Michigan Ave., Chicago, Ill.

Sludge Incineration

438. A multiple hearth furnace which meets the most exacting municipal sanitary requirements for the incineration of sewage sludge—produces a fine ash or partially dry sludge for fertilizer—is described and illustrated with drawings and photographs in bulletins issued by Nichols Engineering and Research Corp., 40 Wall St., New York, N. Y. Operation as well as installation data is given.

440. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Suggestions for plant inspection, 45 pp., ill. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 202P East 44th St., N. Y.

Swimming Pool Equipment

444. Filters, chlorination, underwater lights and other supplies for swimming pools are very thoroughly described in literature and folders. Plans and layouts. Everson Filter Co., 625 W. Lake St., Chicago, Ill.

445. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

Treatment

448. New 31-page catalog covers complete conveying, screening and reduction machinery for water purification and sewage treatment; describes and illustrates the design features of Jeffrey self-cleaning bar screen, combined screen and grinder, sewage screenings grinder, grit washer, conveyor type and positive discharge sludge collectors and green garbage grinder—includes installation views. Catalog 615, Jeffrey Manufacturing Co., Columbus, Ohio.

450. Standard Sewage Siphons for small disposal plants and PFT Rotary Distributors are new catalogs recently issued by Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill. The latter catalog contains typical plans and many illustrations of actual installations.

452. Eliminate sludge bed troubles, forget about weather conditions, odor nuisance, hail insurance and the like. Full details as to how Oliver United Vacuum Filters overcome these problems will be sent to all interested by Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y.

453. How to avoid sludge and scum troubles in settling tanks explained in detail in Book No. 1542—has excellent drawings and photographs, also specifications. Most important are the carefully prepared capacity tables. Link-Belt Co., 307 N. Michigan Ave., Chicago, Illinois.

454. Full information regarding their newest equipment for sewage treatment and water purification will be sent on request by The Dorr Co., 570 Lexington Ave., New York, N. Y.

Thawing Equipment

460. Complete details concerning this quick-acting, efficient, electric pipe thawer which sells for only $39.25 complete, will be sent promptly by Commonwealth Mfg. Corp., Dept. P-710, 3785 Beachmont Ave., Cincinnati, Ohio.

Water Works Operating Practices

490. This is a reprint of two excellent papers by F. E. Stuart. One outlines a number of filtration and field practices of value. The other presents a lot of kinks the author has picked up in visits to more than 1,000 water works plants. Sent free by Activated Alum Corp., Curtis Bay, Baltimore, Md.

For the Engineer's Library

Brief reviews of the latest books, booklets and catalogs for the public works engineer.

Control and Measurement of Sewage and Sludge:

This booklet, prepared by C. G. Richardson, goes considerably beyond the commercial phase of the subject, and contains material of real value to engineers in the sewage field. It illustrates the uses and locations of measuring and controlling devices, by means of a plant layout. This is followed by a brief general discussion of the purpose and use of the various kinds of devices used for this purpose; Venturi tubes are illustrated and discussed, as is the selection of metering instruments. Other subjects covered include flow and ratio gauges; flumes, nozzles and weirs; automatic chemical feeders, constant and proportional; continuous sludge weighing; Venturi meter tube dimensions and capacities; and suction well level and pump control. 24 pp., illustrated. Sent on request to Builders' Iron Foundry, 9 Codding St., Providence, R. I.

Hydrotite Booklet:

This is one of the finest catalogs we have seen for some time. Of the 48 pages, alternate pages — and several in addition—are filled with handy hydraulic data. Among the many heads are: Carrying capacity by fire flow test; contents of pipe; chemical conversion factors; weir discharge table; required fire flows; flow per minute from various fixtures; pipe flow diagram; standard colors for fire hydrants; testing water mains; disinfecting mains; meter efficiencies, and many others. Send to Hydraulic Development Corp., 50 Church St., New York, N. Y., for copy; no obligation.

Municipal and Rural Sanitation: By Victor M. Ehlers and Ernest W. Steel. 462 pages; 162 illustrations. McGraw-Hill Book Co., N. Y. $4.

This is the second edition of a very fine and exceedingly handy book. It covers a whole lot of material that is found with difficulty elsewhere. Moreover, it is well-written, and written by men who know what it's all about from actual experience.

We recommend this book especially for sanitary inspectors, city engineers, health officers and others interested primarily in sanitation. The treatment of municipal water supplies and of municipal sewerage is, purposely, very sketchy. There are texts entirely devoted to these subjects, but for the following subjects, the material presented here is definitely superior: Excreta disposal, household water supplies, refuse collection and disposal, mosquito and fly control, rat and rodent control, milk sanitation, food, plumbing, ventilation, light, housing, industrial hygiene, swimming pool sanitation, disinfection, vital statistics and public health organization.

Mr. Ehlers is chief sanitary engineer of the State Health Department of Texas; Mr. Steel is professor of Municipal and Sanitary Engineering at Texas Agricultural and Mechanical College.

Social Characteristics of Cities: By William F. Ogburn. 70 pages. International City Managers Ass'n., Chicago. $1.

This is a study of population traits, of different types of cities, of wealthy and of industrial suburbs, of increasing and decreasing cities, and of population and government changes. It is illustrated with a number of charts and graphs.

Plumbing Engineering: By Walter S. L. Cleverdon. 429 pages; 160 illustrations. Pitman Publishing Corp., N. Y. $3.50.

Prof. Cleverdon has done a great deal of writing along this line and has the necessary information available to make a most complete and handy text; also, he knows how to write. The result is a worthwhile book. Among the chapters are: Hydraulics and Pneumatics, Water Supply and Consumption, Pumps for Water and Sewage, Water Supply Piping for Buildings, Meters, Tanks, Building Distribution System, Sewage Plumbing, Contracts and Specifications, Refrigeration, Drinking Water Systems, Plumbing in Summer Camps, and Heating, Ventilating and Air Conditioning.

Public Works Engineers Year Book: Issued by the American Society of Municipal Engineers and the International Association of Public Works Officials, Chicago, Ill. $3.

Essentially this text is a resume of the proceedings of the above societies for the year 1936. It contains papers on streets and roads, sewerage and sewerage disposal, water supply, refuse collection and disposal, city planning and housing and traffic safety. There is a roster of members and some advertising.

Municipal Year Book, 1937: A publication of the International City Managers' Association, Chicago, Ill. 599 pages. Clarence E. Ridley and Orin F. Nolting, editors. $5.

In Part I, 129 pages, municipal administration is discussed from 24 viewpoints (as organization, accounting, purchasing, etc.) by experts in these different lines. In Part II, 74 pages, is a discussion of governmental units, with governmental data covering the 960 cities of more than 10,000 population. Part III is devoted to municipal personnel and also gives directories of certain of the city officials in cities of more than 10,000 population. This section contains 144 pages. Part IV is devoted to municipal finance, including the financing of relief and recovery. Part V covers sources of information, being about 80 pages in length.

INDEX TO ADVERTISEMENTS